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Port Hueneme, California 93043-4370

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## Contract Report CR-98.18-SHR

# EFFECT OF MOISTURE AND TEMPERATURE OF CEMENT MORTAR SURFACES ON QUALITY OF ADHESIVE BOND

An Investigation Conducted By

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19990112 001

September 1998

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 PRINTED ON  
RECYCLED PAPER

| REPORT DOCUMENTATION PAGE   |  |   | Form Approved<br>OMB No. 0704-018                        |   |
|---|--|---|--|---|
| Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.  |  |   |  |   |
| 1. AGENCY USE ONLY (Leave blank)  |  | 2. REPORT DATE<br>September 1998                        |  | 3. REPORT TYPE AND DATES COVERED<br>Final; May 1998 through July 1998 |
| 4. TITLE AND SUBTITLE<br>EFFECT OF MOISTURE AND TEMPERATURE OF CEMENT MORTAR SURFACES ON QUALITY OF ADHESIVE BOND   |  |   | 5. FUNDING NUMBERS                                       |   |
| 6. AUTHOR(S)<br>Narayan R. Joshi, PhD, Prairie View A&M University  |  |   |  |   |
| 7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)<br>Prairie View A&M University<br>Prairie View, TX 77446   |  |   | 8. PERFORMING ORGANIZATION REPORT NUMBER<br>CR 98.18-SHR |   |
| 9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESSES<br>Office of Naval Research      Naval Facilities Engineering Service<br>800 Quincy St.                      Center<br>Arlington, VA 22217-5660      1100 23rd Avenue<br>Port Hueneme, CA 93043-4370  |  |   | 10. SPONSORING/MONITORING AGENCY REPORT NUMBER           |   |
| 11. SUPPLEMENTARY NOTES   |  |   |  |   |
| 12a. DISTRIBUTION/AVAILABILITY STATEMENT<br>Approved for public release; distribution unlimited.  |  |   | 12b. DISTRIBUTION CODE                                   |   |
| 13. ABSTRACT (Maximum 200 words)<br><br>Carbon fiber reinforced plastics (CFRPs) are receiving greater utilization in many structural applications due to their excellent mechanical and corrosion resistance characteristics. In addition, they can be designed and fabricated to get adequate strength and stiffness by changing the angle and the sequence of their laminations. The composite materials are increasingly used in industries of aerospace, automobile, ship, leisure and sports. Applications in strengthening existing reinforced concrete beams, piles, and decks using carbon fiber sheets are also being pursued. Carbon fiber sheets are utilized to strengthen waterfront concrete structures such as wharves and piers. The sheets are bonded to the underside of reinforced concrete pier using structural adhesives. Structural bonding implies the use of adhesives in an engineering application. A bonded joint should be capable of withstanding the stresses to be transmitted under different environmental conditions and over many years of service life. In this study three structural adhesives, i.e. epoxy resin systems, were chosen to establish adhesive bonds to the hydraulic cement mortar cubes. The assemblies were subjected to the combinations of three different temperatures and four different relative humidities in an environmental control chamber. Effects of moisture and temperature on the quality of bonds were investigated using pull-off tests. Results are reported describing different types of failures observed. |  |   |  |   |
| 14. SUBJECT TERMS<br>Chloride, epoxy, carbon fibers, piles, reinforced concrete   |  |   | 15. NUMBER OF PAGES<br>87                                |   |
|   |  |   | 16. PRICE CODE   |   |
| 17. SECURITY CLASSIFICATION OF REPORT<br>Unclassified   | 18. SECURITY CLASSIFICATION OF THIS PAGE<br>Unclassified | 19. SECURITY CLASSIFICATION OF ABSTRACT<br>Unclassified | UL   |   |

## EXECUTIVE SUMMARY

Carbon fiber reinforced plastics (CFRPs) are receiving greater utilization in many structural applications due to their excellent mechanical and corrosion resistance characteristics. In addition, they can be designed and fabricated to get adequate strength and stiffness by changing the angle and the sequence of their laminations. The composite materials are increasingly used in industries of aerospace, automobile, ship, leisure and sports. Applications in strengthening existing reinforced concrete beams, piles, and decks using carbon fiber sheets are also being pursued. Carbon fiber sheets are utilized to strengthen waterfront concrete structures such as wharves and piers. The sheets are bonded to the underside of reinforced concrete pier using structural adhesives. Structural bonding implies the use of adhesives in an engineering application. A bonded joint should be capable of withstanding the stresses to be transmitted under different environmental conditions and over many years of service life. In this study three structural adhesives, i.e. epoxy resin systems, were chosen to establish adhesive bonds to the hydraulic cement mortar cubes. The assemblies were subjected to the combinations of three different temperatures and four different relative humidities in an environmental control chamber. Effects of moisture and temperature on the quality of bonds were investigated using pull-off tests. Results are reported describing different types of failures observed.

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## 1. INTRODUCTION

Excellent mechanical and corrosion resistant characteristics have promoted the use of fiber reinforced plastics (FRP's) in many structural applications all over the world. Although the short-term mechanical properties of these materials are usually well documented, long-term durability issues still remain to be researched. The Naval Facilities Engineering Service Center (NFESC) is studying use of fiber reinforced plastics (FRP) to upgrade existing reinforced concrete piers and wharves. Carbon fiber reinforced plastic (CFRP) sheets are bonded to the under-side of reinforced concrete pier decks to increase their structural capacity, in particular to resist large patch loads from mobile crane outrigger floats. Laboratory tests of beam, slab, and pile scale models were conducted to quantify upgrades of moment capacity, shear strength, deflection, and ductility and to determine effects on failure modes. The composite plates and composite fabrics epoxy-bonded to the concrete structure for the purpose of external reinforcement showed great improvement in the performance of the host structure [1]. However, there is not enough information regarding environmental effects on the quality and durability of the bond between the reinforcement and the host structure.

## 2. ADHESIVE BONDS

At present two methods are used to reinforce the host concrete structure by using the carbon fiber reinforced plastics (CFRP). In one method the pre-impregnated plates are bonded to the concrete surface using a structural adhesive such as epoxy resins. In this case the structural adhesive may or may not be different from the polymeric matrix of the composite plate. In the second method, the dry fibrous reinforcement is impregnated with a resin system during placement itself. The composite is thus formed at the same time as it bonds to concrete. The resin thus serves the dual purpose of impregnating and bonding the fibers together, and bonding the composite to the concrete surface. This second method is therefore called a wet lay-up.

Structural bonding implies the use of adhesives in an engineering application. It is expected that the proposed bonded joint will be capable of withstanding the stresses to be transmitted. These stresses will be applied either in tension or shear, or in combination. The adhesive performance at various temperatures has also been studied using double lap joints. It was observed in the case of the adhesive Araldite that there is in general loss of room temperature strength for any gain in high temperature performance [2]. Many adhesive systems such as alkyd, epoxy ester, chlorinated rubber and styrene-butadiene paints showed loss of adhesion in 100% relative humidity (RH) conditions at room temperature. At lower RH values the loss of adhesion effect was less marked [3]. In case of epoxy adhesives it was observed in earlier research investigations that both with polar and non-polar surfaces the



properties of the adhesive joint are determined by an interaction of surface properties, adhesive properties and process variables. Porosity plays the significant role in case of porous materials like cement concrete or mortar. Flaws at the weak interfacial layer can cause poor adhesion [4]. The adhesive bond line thickness also affects the tensile strength. In general it was observed that the thicker the bond line, the lower the tensile strength [5]. The aspect ratio of the adhesive film is defined as the geometric ratio of its bonded area to force-free lateral surface area. Thin adhesive films have this ratio greater than 100. A thin adhesive film cannot contract laterally as a result of the geometric restriction. It has a lower Poisson's ratio than a thick film. The tensile bond strength depends on the aspect ratio [6].

### 3. SCOPE OF THE PRESENT STUDY

It is proposed to limit the present project to the study of the environmental effects (effects of different temperatures and humidities) on the quality of bonds to the hydraulic cement concrete or mortar surface. Out of many available resin systems such as unsaturated polyesters, vinylesters, phenolic resins and epoxies, only epoxies were chosen for the project. This is so because polyester resins are not very resistant to alkalies and are typically avoided for uses in concrete [7]. Vinylester resins are resistant to a wide range of acids as well as to chloride salts making them ideal for marine environments. However, the volume shrinkage of vinylester resins upon cure is significantly higher than for epoxy resins [8]. Phenolic resins have not been used to a wide extent in fiber reinforced composites. They are highly aromatic materials and have very short distances between crosslinkable points. Thus, their cured networks are relatively brittle. Moreover many of them have large volumes of volatiles upon cure [9]. On the other hand, epoxies have many desirable properties as structural adhesives. They cure with only a fraction of the shrinkage of vinyl-type adhesives such as polyesters and acrylics. Consequently, less strain is built into the bond line, and the bond is stronger. They exhibit low creep. The epoxies in the unmodified state cure without releasing water or other condensation byproducts. They are resistant to moisture. Moisture does not affect epoxy but will migrate through the joint and deteriorate the substrate.

Epoxy adhesives are particularly compatible with Portland cement concrete or mortar because of the insensitivity to the alkali and moisture contents of this structural material [10]. It was observed that when epoxy bonded joints are subjected to moisture or water immersion, the failures usually occur at the interface. This indicates the importance of proper surface preparation of the adherends. However, it opens the area of research where there is either no opportunity or limited opportunity to prepare the surface of one of the adherends, say, that of the concrete structure. It was therefore decided to undertake an investigation of the effects of dry and moisturized mortar surfaces on the quality of the adhesive bond. It was proposed to vary both temperature and moisture content of cement mortar cube surfaces by conditioning them in an environmental control chamber.

#### 4. METHODS OF TESTING OF ADHESIVE BONDS

A wide range of approaches is available for estimating the strength of concrete or mortar. These include destructive methods such as cube or cylinder compression to failure testing, nondestructive methods and partially destructive tests. In the last category is included a test called the pull-off test developed originally by A. E. Long [11]. Figure 1 shows schematically the simple arrangement of the pull-off test. It involves bonding a circular steel or aluminum probe to the concrete surface using an epoxy resin adhesive which is stronger than concrete in tension. An increasing tensile load is applied to the disc by means of a portable hydraulic jack. Since the tensile strength of the epoxy resin is greater than that of the concrete, the latter will fail. From the peak load applied to pull off the disc from the concrete, a nominal (engineering) tensile strength of the surface is calculated dividing the force (load) by the area of the disc [12]. The ASTM Standard D4541-93 describes a similar partially destructive test called 'Pull-off test for Adhesion' [13]. It is designed not for the estimation of the tensile strength of the substrate but for the estimation of adhesive strength of a coating to the substrate. In this test an aluminum dolly in place of a steel disc is glued to a coating of the substrate. An instrument called Elcometer 106 Adhesion Tester is then used to pull off the glued dolly normal to the glued surface [14]. In the list of physical/chemical properties of coatings, the bond strength is typically referred to in terms such as 'greater than 200 psi' etc..

Figure 2 shows schematically different types of expected failures of an assembly. Failures are classified as either substrate, adhesive, cohesive or mixed. In the adhesive failure, the adhesive layer separates from the substrate. In the cohesive failure, the adhesive layer breaks into two portions, one remaining attached to the substrate (mortar cube in this case) and the other attached to the dolly. We expected higher number of substrate failures and negligible cases of cohesive failures in this work. In the case of a mixed failure, the percentages of the substrate and adhesive failures will be estimated by careful visual observation using a magnifying glass [15]. This new version of the original 'Pull-off Test' thus can be used for different purposes. It can be used to measure tensile strength of a cement concrete or mortar as in the original version, or the adhesion strength of a coating on a concrete surface, or the adhesive strength of the glue used to attach the aluminum dolly to the plain surface of a concrete. The test could also be used to study the effect of contaminated concrete surface on the adhesion of a coating to the surface [16]. Contaminants at the concrete surface affect osmotic pressure and adhesion. Different versions of the pull-off test are useful for in-situ testing of concrete specimens of big size. For small size specimens of cement concrete or mortar cubes of 2 inches in dimension, a tensile testing machine like Instron or MTS, could be used to get data more accurately than that could be read from the Elcometer instrument primarily designed for paint and coating testing.

## 5. EXPERIMENTAL SETUP

It was decided to use the "Pull-off Test" for the purpose of studying the effects of the moisture on the quality of adhesive bonds to cement mortar surfaces. The test specimens prepared were the assemblies of mortar cubes, epoxy resin and sand blasted aluminum dollies as shown in Figure 3. Three different temperatures (70°F, 85°F and 100°F) and four different relative humidities at each temperature (50% RH, 65% RH, 80% RH and 95% RH) were chosen for the study. About 108 mortar (Portland cement + sand + water) cubes of dimension 2 x 2 x 2 in were cast using plastic molds (impermeable formwork of polypropylene plastic material). The sand to cement ratio of the mortar was 3:1 and the water to cement ratio 0.5. The cubes were kept moist for 28 days. After that period they were kept in the laboratory at ambient temperature and humidity. On one of the smooth faces of each mortar cube an aluminum dolly was attached using the structural epoxy adhesive. A dolly resembles an hourglass in shape, about half an inch tall, and three quarter inch in diameter. Figure 3 shows the dimensions of the cement mortar specimens used in the experimental work.

The mortar cube surfaces were wire brushed and then dusted off with a soft brush making them free of laitance and contamination. The surface abrasion of the dollies helped establish the proper mechanical anchoring to the mortar surface through a thin film (less than 1/16 in thick) of an epoxy resin. It was decided to use three different epoxy resins - Sikadur 30, Sikadur 32 Hi-Mod, and Madewell 1312F to glue the aluminum dollies to the brushed surfaces of the cubes. All three epoxy resins are two-component systems. They were mixed and stirred according to specifications recommended by their manufacturers. These are listed in the Appendix. For each cube, two dollies were attached one on the surface coated with a thin layer of a primer and other on a surface without primer. The primer Sikadur 55 SLV was used with resins Sikadur 30 and 32. The primer Madewell 927 was used with the resin Madewell 1312F. Their specifications are also included in the Appendix. A primer works as a penetrant as well as sealer. It was expected to fill micropores in concrete or mortar and not air bubbles or blow holes. Only a thin layer (1 mil or 2 mils) of primer is supposed to perform its expected function. The thickness of a dolly and a cube pair were measured separately using vernier caliper. Their masses were also measured.

Dollies were mounted on the surfaces of the mortar cubes using thin layers of epoxy resins and were held in position for a couple of minutes with a constant pressure. Three samples for each epoxy system were prepared. So for a chosen pair of temperature and relative humidity, 9 samples, three each for three epoxies, were prepared each carrying two dollies, one on a surface with primer and another on a surface without primer. For four different relative humidities at the same temperature, a total of 36 samples was conditioned. For three different temperatures, the total added to 108 samples. The tensile tests performed were similar to the ASTM Standard D4541-93-Pull-Off Strength of Coatings. Instead of using a portable Elcometer 106 Adhesion Tester, the pull-off tests were carried out by using a computerized Instron Testing Machine. A special fixture was prepared to align the mortar cube with a dolly along the vertical axis of the tensile loading machine so that the applied load

was normal to the cube surface. Misalignment was avoided because it can change a tensile test into a peel-off test.

Each set of 9 cubes was cured for 7 days in the environmental control chamber set at the chosen values of temperature and relative humidity. The procedure was repeated for 12 sets. After 7 days, assemblies were taken out of the chamber. The total thickness of each assembly was measured using the vernier caliper. By subtracting the individual thickness of the dolly and the cube from the thickness of the assembly, the thickness of the epoxy layer was computed. The excessive epoxy layers around the base of the attached dollies were removed using the testing apparatus sharp hollow cylindrical scraper before the pull-off tests. The assemblies were pulled off using the special fixture (Figure 4) attached to the Instron testing machine Model 4206. The elongation rate for all 216 tests was fixed at 0.01 inch per minute. A 1000 lb capacity load cell of was used. The load range of 500 lb (on the Y-axis) and the elongation range of 0.5 inch (on the X-axis) were set for all tests.

## 6. EXPERIMENTAL DATA

A computer equipped with a data acquisition system acquired load and elongation values during each test and plotted them on the screen. For each test, peak tensile load to pull-off the dolly was recorded. After the break of the assembly, the dolly with the pulled-off portion of substrate was weighed again to calculate only the detached mass of the substrate. The combined thickness of the dolly and the mortar chunk at the point of the deepest extent was measured to calculate the maximum depth of the mortar chunk. Viewing through the magnifying glass, the percentages of the mixed failures were estimated. Thus for each test, the mass of the mortar cube, the peak load to pull off the dolly, the adhesive film thickness, the pulled-off mass of mortar layer, maximum depth of the detached mortar layer and types of failures that occurred were recorded.

For the chosen pair of the temperature and relative humidity, six tests were run for each of three epoxy resins. This group of 18 tests is called Set #1. For three different temperatures and four different RH values, a total of 216 tests were performed grouped among twelve sets. In a given set, for each epoxy there were three tests for dollies attached to surfaces with no primer and another three to surfaces with primer. On each cube two dollies were attached, one on the surface as it was and the other on the surface carrying a thin coating of the primer. The twelve sets thus constituted the initial direct data from physical measurements and testing. Later on, the average peak load was calculated from three tests on the surfaces with no primer. The procedure was repeated for three tests on surfaces with primer. The data from twelve sets from 1 to 12 are presented in Tables 1 to 12.

The following abbreviations were used in the test names.

- 1) In Set #1, the nine tests are named N11 to N19. In Set #8, the tests were named N81 to N89 and so on. Thus the first test was N11 and the last was N129 in Set #12, adding to 108.
- 2) The suffix 'P' indicates a test on a surface with primer. These tests are named N11P to N19P. Thus the first test was N11P and the last was N129P in Set #12, adding to 108.
- 3) The tests in which the pulled-off mortar mass was found to be equal to, or greater than 1.5 grams are identified with the star (\*) at the end of their names.
- 4) The tests in which the mounted dollies slid down from the original location but stayed glued on the surface are identified with the suffix 'SL'.
- 5) When the dollies did not stick at all to the surface or were pulled off with a peak load less than 25 pounds, the suffix 'X' was attached to their test names. The value of zero was entered for the peak load. The peak load of such test was excluded from the average.
- 6) The suffix 'R' was attached to those tests which were repeated.

## **7. REGROUPING AND PLOTTING OF DATA**

In order to study the performance of the three epoxy resins separately, at different combinations of temperatures and relative humidities, new tables were constructed for each one of them. Thus Table 13 describes the performance of the adhesive Sika 30 at a temperature of 70°F, and at different relative humidities. Table 14 does the same at 85°F and Table 15 at 100°F.

From Table 13, three new data tables were constructed. In Table 13A, tests with primer are separated from those without primer. In Table 13B, the average of three peak loads is calculated for a single relative humidity (RH%) value. The procedure is repeated for adhesive film thickness, pulled off mass of mortar layer, and its thickness. Masses of individual cubes were also entered into tables. Their averages were not performed since they carry no significance for this study. In Table 13C, only average values of peak loads were listed. Thus two average peak load values (one with primer and other without primer) corresponded to a single pair of temperature and relative humidity values. These are used in plotting of experimental data for the purpose of comparing performance of the three different epoxy systems.

The procedure was repeated for the adhesive Sika 32 in Table 16 (with 16A, 16B and 16C), Table 17 (with 17A, 17B, and 17C) and Table 18 (with 18A, 18B, and 18C). One more repetition is performed for the adhesive Madewell 1312F in Table 19 (with 19A, 19B, and 19C), Table 20 (with 20A, 20B, and 20C), and Table 21 (with 21A, 21B, and 21C).

The regrouped data of the epoxy Sika 30 from Tables 13C, 14C and 15C were plotted in Figures 5, 6, and 7. The regrouped data of the epoxy Sika 32 from Tables 16C, 17C and 18C were plotted in Figures 8, 9, and 10. The regrouped data of the epoxy Madewell 1312F from Tables 19C, 20C, and 21C were plotted in Figures 11, 12 and 13.

Data on types of failures from the last columns of Set #1 to Set #12 were regrouped in Table 22 to study their distributions at different temperatures and relative humidities irrespective of the epoxy resins used. The regrouped data from Table 22 were plotted as three different bar graphs, one for each temperature, in Figure 14 for 70°F, in Figure 15 for 85°F and in Figure 16 for 100°F.

## **8. EXPERIMENTAL RESULTS**

### **8.1. Adhesive Sika 30**

Figures 5, 6 and 7 show the behavior of the adhesive Sika 30 at three different temperatures. On each plot, there are two curves of the average tensile peak loads (ATPL), one for no primer and the second for with primer. Each point is the average of three tests. Curves are drawn through four data points at four different relative humidities.

#### **8.1.1. Without primer**

The maximum ATPL is 254.83 lbs at 70°F and 50% RH. The minimum ATPL is 121.8 lbs at 85°F and 50% RH. In general, the ATPL have decreased in going from lower temperature to the higher temperature.

#### **8.1.2. With primer**

The maximum ATPL is 284.53 lbs at 70°F and 50% RH. The minimum ATPL is 129.16 lbs at 100°F and 50% RH. In general, the ATPL have decreased in going from lower temperature to the higher temperature.

Both the maximum and minimum ATPL have values higher in tests with primer than those in tests without primer. However the curve of ATPL with primer is not above the curve without primer at all temperatures and relative humidities as expected.

## **8.2. Adhesive Sika 32**

Figures 8, 9, and 10 show behavior of the adhesive Sika 32 at three different temperatures. On each plot there are two curves of ATPL, one for tests with primer and the other for tests without primer. Each point is the average of three tests. Curves are drawn through four data points at four different relative humidities.

### **8.2.1. Without primer**

The maximum ATPL is 381.4 lbs at 85°F and 80% RH. The minimum ATPL is 122.7 lbs at 100°F and 95% RH. In general, the ATPL have values higher at 85°F than those at the lower and the higher temperatures.

### **8.2.2. With primer**

The maximum ATPL is 380.8 lbs at 70°F and 50% RH. The minimum ATPL is 222 lbs at 100°F and 95% RH. In general the ATPL have increased in going from the lower temperature to the higher temperature.

Both the maximum and minimum ATPL have values higher in tests with primer than those in tests without primer. The curve of ATPL with primer is most of the time at a higher load level than the curve without primer, as expected.

## **8.3. Adhesive Madewell 1312F**

Figures 11, 12, and 13 show behavior of the adhesive Madewell 1312F at three different temperatures. Each plot shows two curves of ATPL, one for tests with primer and other for tests without primer. Each point is the average of three tests. Curves are drawn through four data points at four different relative humidities.

### **8.3.1. Without primer**

The maximum ATPL is 360.7 lbs at 100°F and 50% RH. The minimum ATPL is 118.5 lbs at 100°F and 95% RH. In general, the ATPL have increased in going from the lower temperature to the higher temperature.

### **8.3.2. With primer**

The maximum ATPL is 436.3 lbs at 100°F and 50% RH. The minimum ATPL is 235.6 lbs at 70°F and 65% RH. In general, the ATPL have increased in going from the lower temperature to the higher temperature.

Both the maximum and the minimum ATPL have values were higher in tests with primer than those in tests without primer. The curve of ATPL with primer is most of the time at a higher load level than the curve without primer, as expected.

#### 8.4. The Range of Average Tensile Peak Loads

Among all three epoxy systems (resins with primers), the highest ATPL is 436.3 lbs for Madewell 1312F with primer at 100°F and 50% RH.

Among all three epoxy systems, the lowest ATPL is 118.5 lbs for Madewell1312F without primer at 100°F and 95% RH.

Table A: Maxima and Minima in ATPL for Three Epoxy Resin Systems

| EPOXY RESIN | PRIMER | ATPL (LBS) | NATURE       | TEMPERATURE (°F) | RH% |
|-------------|--------|------------|--------------|------------------|-----|
| Sika30      | No     | 254.8      | Max          | 70               | 50  |
| Sika30      | Yes    | 284.5      | Max          | 70               | 50  |
| Sika30      | No     | 121.8      | Min          | 85               | 50  |
| Sika30      | Yes    | 129.2      | Min          | 100              | 50  |
| Sika32      | No     | 381.4      | Max          | 85               | 80  |
| Sika32      | Yes    | 380.8      | Max          | 70               | 50  |
| Sika32      | No     | 122.7      | Min          | 100              | 95  |
| Sika32      | Yes    | 222.0      | Min          | 100              | 95  |
| Madewell    | No     | 360.7      | Max          | 100              | 50  |
| Madewell    | Yes    | 436.3      | Max(highest) | 100              | 50  |
| Madewell    | No     | 118.5      | Min(lowest)  | 100              | 95  |
| Madewell    | Yes    | 235.6      | Min          | 70               | 65  |

Out of 6 maxima of ATPL, 5 occurred at 50% RH, only one occurred at 80% RH and none occurred at the highest value 95% of RH used in the tests. Out of 6 minima of ATPL, 3 occurred at 95% RH, 2 occurred at 50% RH and only 1 occurred at 65% RH.

For the effect of temperature on ATPL, 3 maxima occurred at 70°F, 2 occurred at 100°F and only 1 occurred at 85°F. In the case of ATPL minima, 4 occurred at 100°F, 1 occurred at 85°F and 1 occurred at 70°F.

The diameter of a dolly was 0.787 inch (20 mm) and its area was 0.487 square inch. The greatest ATPL of 436.3 pounds is equivalent to 896 psi. The lowest ATPL of 118.5 pounds is equivalent to 243 psi.

The compression tests were run on three mortar cubes from the same stock from which 108 cubes were taken for the project. The average compressive strength was found to be 5000 psi. At this point it was found necessary to investigate the number of types of failures at



different combinations of temperatures and relative humidities. This data is presented in Table 22.

## 8.5. Types of Failures

In the assembly of the layered structure of aluminum dolly, adhesive film and the substrate of the hydraulic cement mortar cube, the weakest link was expected to be the substrate. Not in a single case was there any separation between the aluminum dolly and the adhesive used.

Out of 216 tensile pull-off tests, the 100% substrate failures occurred in 127 tests, equivalent to 59 percent. The 100% substrate failure means that the whole area of the pulled off dolly was covered with substrate. In the case of 80% substrate failures, the remainder 20% would be adhesive failure or interface separation.

In addition:

- between 99% to 80% substrate failures occurred in 50 tests equivalent to 23 percent;
- between 79% to 60% substrate failures occurred in 13 tests equivalent to 6 percent;
- between 59% to 1% substrate failures occurred in 22 tests equivalent to 10 percent;
- one hundred percent adhesive failures occurred in 3 tests equivalent to 1.4 percent;
- only one cohesive failure occurred equivalent to 0.5 percent.

The highest number (18) of 100% substrate failures occurred at 70°F and 50% RH. The lowest number (3) of 100% substrate failures occurred at 100°F and 95% RH.

For all epoxy resin systems used and at all RH settings the highest number (51) of 100% substrate failures occurred at 70°F. That number was followed by the smaller number (44) at the increased temperature of 85°F, and finally by the smallest number (32) at the highest temperature of 100°F. The data from Table 22 was plotted separately in Figures 14, 15, and 16 as three bar graphs for three different temperatures.

## 8.6. Strong Bonds

In certain tests, although the type of failure was 100% substrate, the mass of detached substrate was a thin layer attached to the adhesive film below. In a few other tests, big chunks of substrate were pulled off by the dolly. The tests with the pulled-off mass of substrate greater than or equal to 1.5 grams were identified by the star (\*) sign in Tables 1 through 12. They are identified as strong bonds. The 35 strong tests are listed below.

Table B: Tests with Detached Substrate Mass Equal to or Greater than 1.5 grams.

| TEST  | RESIN  | PRIMER | PEAK<br>LOAD<br>(LBS) | MORTAR<br>MASS<br>(GR) | TEMP<br>(°F) | RH<br>(%) | TYPE OF<br>FAILURE |
|-------|--------|--------|-----------------------|------------------------|--------------|-----------|--------------------|
| N13   | Sika30 | No     | 275.2                 | 2.639                  | 70           | 50        | 100%S              |
| N12P  | Sika30 | Yes    | 297.7                 | 2.595                  | 70           | 50        | 100%S              |
| N13P  | Sika30 | Yes    | 332.9                 | 3.087                  | 70           | 50        | 100%S              |
| N16   | Sika32 | No     | 452.6                 | 3.530                  | 70           | 50        | 100%S              |
| N14P  | Sika32 | Yes    | 390.9                 | 2.727                  | 70           | 50        | 100%S              |
| N18   | MW     | No     | 315.2                 | 1.746                  | 70           | 50        | 100%S              |
| N18P  | MW     | Yes    | 329.4                 | 2.097                  | 70           | 50        | 100%S              |
| N21P  | Sika30 | Yes    | 235                   | 1.882                  | 70           | 65        | 100%S              |
| N26P  | Sika32 | Yes    | 436                   | 1.814                  | 70           | 65        | 100%S              |
| N28P  | MW     | Yes    | 167.3                 | 1.85                   | 70           | 65        | 100%S              |
| N29P  | MW     | Yes    | 233.6                 | 2.103                  | 70           | 65        | 100%S              |
| N45   | Sika32 | No     | 242.5                 | 1.887                  | 70           | 95        | 100%S              |
| N46   | Sika32 | No     | 200.7                 | 1.998                  | 70           | 95        | 100%S              |
| N48P  | MW     | Yes    | 369                   | 1.924                  | 70           | 95        | 100%S              |
| N55P  | Sika32 | Yes    | 252.8                 | 1.686                  | 85           | 50        | 100%S              |
| N56P  | Sika32 | Yes    | 483.8                 | 1.677                  | 85           | 50        | 100%S              |
| N61   | Sika30 | No     | 237.6                 | 1.686                  | 85           | 65        | 100%S              |
| N66   | Sika32 | No     | 281.3                 | 2.027                  | 85           | 65        | 100%S              |
| N65P  | Sika32 | Yes    | 303.2                 | 1.697                  | 85           | 65        | 98%S               |
| N67   | MW     | No     | 277.9                 | 2.105                  | 85           | 65        | 100%S              |
| N67P  | MW     | Yes    | 256                   | 1.731                  | 85           | 65        | 100%S              |
| N75   | Sika32 | No     | 340.1                 | 3.947                  | 85           | 80        | 100%S              |
| N75P  | Sika32 | Yes    | 439.2                 | 2.135                  | 85           | 80        | 95%S               |
| N76P  | Sika32 | Yes    | 373.7                 | 2.640                  | 85           | 80        | 100%S              |
| N78   | MW     | No     | 320.8                 | 1.557                  | 85           | 80        | 100%S              |
| N84P  | Sika32 | Yes    | 318                   | 2.227                  | 85           | 95        | 100%S              |
| N85P  | Sika32 | Yes    | 280.9                 | 1.514                  | 85           | 95        | 100%S              |
| N86P  | Sika32 | Yes    | 270.6                 | 1.697                  | 85           | 95        | 100%S              |
| N89P  | MW     | Yes    | 370.6                 | 2.720                  | 85           | 95        | 100%S              |
| N94   | Sika32 | No     | 322.5                 | 1.715                  | 100          | 50        | 100%S              |
| N95P  | Sika32 | Yes    | 319.5                 | 2.075                  | 100          | 50        | 100%S              |
| N105  | Sika32 | No     | 276.9                 | 3.110                  | 100          | 65        | 100%S              |
| N108  | MW     | No     | 320.4                 | 1.565                  | 100          | 65        | 100%S              |
| N121  | Sika30 | No     | 176.5                 | 1.628                  | 100          | 95        | 100%S              |
| N127P | MW     | Yes    | 209                   | 1.608                  | 100          | 95        | 100%S              |

Out of 35 strong tests, 6 tests belonged to Sika 30, 18 belonged to Sika 32 and 11 belonged to Madewell 1312F. Tests with primer were 21, and without primer 14. The distribution at different temperatures was 15 tests at 85°F, 14 at 70°F and only 6 at 100°F. The distribution at different relative humidities was 11 tests each at 50% and 65% RH, 4 tests at 80% RH and 9 tests at 95% RH.

## 8.7. Weak Bonds

The peak pull-off load was less than 25 lbs in 6 tests out of 216 tests. The samples with improper adhesion, either due to the experimental error or due to other causes, were only 2.8 percent of the whole set. These were excluded from the average of the peak pull-off load. Out of 6 tests, 3 tests were on surfaces without primer and other 3 were on surfaces with primers. They are listed below.

Table C: List of Tests with Peak Pull-Off Load less than 25 lbs.

| TEST  | ADHESIVE      | PRIMER | TEMPERATURE<br>(°F) | RH (%) |
|-------|---------------|--------|---------------------|--------|
| N51   | Sika30        | No     | 85                  | 50     |
| N123  | Sika30        | No     | 100                 | 95     |
| N127  | Madewell1312F | No     | 100                 | 95     |
| N32P  | Sika30        | Yes    | 70                  | 80     |
| N57P  | Madewell1312F | Yes    | 85                  | 50     |
| N124P | Sika32        | Yes    | 100                 | 95     |

All three epoxies are involved. All three temperatures are involved. In the three cases with primers on the surfaces, thicker coats could be the cause of improper adhesion. In the three cases with RH 95% at 100°F, the moist surfaces could be cause of improper adhesion. Since they were excluded in calculating the average peak loads, their influence on the tests results is nil.

## 8.8. Effects of Adhesive Bond Thickness on Pull-Off Strength

Attention was given to apply a thin uniform layer of the adhesive to the sand blasted surfaces of the dollies first, and then set them on the mortar surfaces with primer and without primer in pre-selected positions. They were held in positions by moderate pressure. All three

adhesives were in liquid paste form and hence got squeezed out from under the dollies. There was no control, therefore, on the thickness of the adhesive film between the dolly and the mortar surface. The adhesive film thickness were computed and are documented in Tables 1 to 12. It was observed that the resin Sika 30 formed films thicker than Sika 32 that in turn formed films thicker than Madewell 1312F. But the adhesive film thickness was also affected by the microscopic variations in the morphology of the individual mortar surfaces. No efforts, therefore, were made to establish the relationship between adhesive film thickness and the pull-off strength, although it was observed that the thicker films lead to the lower values of pull-off strengths in tests that could be reasonably compared with each other.

## 9. DISCUSSION OF RESULTS

Nine figures, from Figure 5 to Figure 13, are the plots of average tensile peak load (ATPL) versus relative humidity (RH) at 3 different temperatures for 3 epoxy resin systems. Among the resin systems, the curves of Sika 32 show ATPL, in general, at values higher than those of Sika 30, as expected. Between Sika 32 and Sika 30, the general trend can be explained by the difference in properties, as described by the manufacturer. The 7day cure tensile strength (ASTM D-638) of Sika 30 is 3600 psi, while that of Sika 32 is 5100 psi. Thus performance of Sika 32 was expected to be better than that of Sika 30. It was observed accordingly in this work. The data on the 7-day cure tensile strength of Madewell 1312F was not available.

The nine plots of Figures 5 to 13 show the improvement in the values of ATPL with the application of primer. It is interesting to note that the effect of primer becomes more dominant at higher temperatures for all resin systems, at all relative humidities. Primers may prevent outgasing from the substrate at higher temperatures, and thus improve the performance of the adhesive bond.

The bar graphs of Figures 14, 15, and 16 show trends in substrate and adhesive failures. The number of substrate failures decreased and that of adhesive failures increased in the environment of higher temperatures and relative humidities.

Among the strong tests, the number of those with primer is 1.5 times the number of those without primer. The number of strong tests decreased in the environment of higher temperatures and relative humidities.

Although the general trends observed in the averaged experimental data are consistent with properties of adhesives described by their respective manufacturers, deviations from the general trends were also observed in the individual data points. This may be due to certain

chemical reactions (such as cross-linking) being accelerated at higher temperatures and certain other reactions being prevented from happening at a high relative humidity environment.

## 10. CONCLUSIONS

The total number of 100% adhesive failures was only 3 out of 216 tests. Out of 3, two occurred at 100°F and 95% RH, only one occurred at 85°F and 50% RH and none occurred at 70°F. Thus only 1.4% bonds turned out to be bad bonds.

It can be concluded, therefore, that all three epoxy resin systems performed their intended function of establishing a bond to the hydraulic cement mortar surfaces in the temperature range of 70°F to 100°F and in the RH% of 50 to 95. This happened 213 times out of 216, which is equivalent to 98.6% of the time.

The total number of mix failures (1% adhesive to 99% adhesive or equivalently 99% substrate to 1% substrate) was 85 out of 216 tests equivalent to 39 percent. It can be said therefore, that in 39% cases, bonds varied from good to fair to weak. The cases of 6 weak bonds are included in the mix failure category because they pulled out some substrate, albeit a small piece.

The total number of 100% substrate failures (better bonds) was 127 out of 216 equivalent to 59%. These cases do not tell us about the state of the bond unless we compare them on the basis of the quantity of mortar they pulled off. Out of these are selected 35 tests that pulled a mortar mass greater than 1.5 grams. These are the best bonds. The adhesive bond performance is summarized in the Table D.

Table D: Summary of Quality of Bonds

| SERIAL NO. | BOND QUALITY     | QUANTITY |
|------------|------------------|----------|
| 1          | Best             | 35       |
| 2          | Good             | 92       |
| 3          | Fair to weak     | 85       |
| 4          | No bond          | 3        |
| 5          | Cohesive failure | 1        |
| Total      |                  | 216      |

## **11. RECOMMENDATIONS**

In the research work reported here, there was no way to know the condition of the adhesive film formed under the dolly in contact with the mortar cube surface before subjecting it to a destructive test like the pull-off test. Sometimes a kissing bond is formed with intermittent contact with the substrate rather than a uniform bond. Sometimes the film becomes thicker on the edges. These non-uniformities in thickness and contact as well as gaps in the adhesive film can be detected prior to destructive testing by means of nondestructive techniques such as ultrasonics. This process will bring control on the formation of adhesive films. It will lead to the understanding of their true performance without being colored by the effects of the film defects.

## **12. ACKNOWLEDGMENTS**

I would like to thank Mr. Jeff P. Jarosz of the Navy-ASEEE summer faculty program and Mr. Don Brunner, the director of the Waterfront Materials Division of Naval Facilities Engineering Service Center at Port Hueneme, California for the financial support of this project. I would like to thank Dr. Javier Malvar for suggesting the research project and for expert guidance throughout the period of the project. I am grateful to the department engineers and scientists- Dr. Thomas Novinson, Dr. George Warren, David Gaughen, Robert Jamond, Daniel Polly, David Hoy, Daniel Zarate, Christopher Inaba, Steve Harwell and Theresa Hoffard, for taking time out of their regular duties to assist me in technical details and to participate in stimulating discussions with me on the project and other research activities of the department. Special thanks to Robert Jamond for assistance in the tests with the Instron Testing Machine and to David Gaughen for assistance in the Elcometer and other tests. The project would not have been completed in the short period of the summer months without active cooperation of the staff members, Rose Cardenas (the secretary), Nathalie Milliken, John Crahan and Monte Faust. I am indebted to them also.

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Table 1. Set #1 – Temperature 70°F, Relative Humidity 50%.

| TEST   | Mass of Mortar Cube<br>grams | Peak Load to pull off dolly<br>pounds | Adhesive Film Thickness<br>inch | Pulled off Mass of Mortar Layer<br>grams | Max Height of Mortar Layer<br>inch | Type of Failure<br>S=substrate<br>A=adhesive<br>C=cohesive |
|--|------------------------------|---------------------------------------|---------------------------------|--|------------------------------------|--|
| Adhesive Sika 30 without Primer                  |                              |                                       |                                 |  |                                    |  |
| N11  | 280.312                      | 168.3                                 | 0.012                           | 0.573                                    | 0.058                              | 100%S  |
| N12  | 279.058                      | 321                                   | 0.008                           | 0.716                                    | 0.104                              | 100%S  |
| N13*   | 275.824                      | 275.2                                 | 0.012                           | 2.639                                    | 0.199                              | 100%S  |
| Adhesive Sika 30 with Primer Sika 55             |                              |                                       |                                 |  |                                    |  |
| N11P   | 280.312                      | 223                                   | 0.020                           | 0.594                                    | 0.077                              | 100%S  |
| N12P*  | 279.058                      | 297.7                                 | 0.010                           | 2.595                                    | 0.179                              | 100%S  |
| N13P*  | 275.824                      | 332.9                                 | 0.007                           | 3.087                                    | 0.213                              | 100%S  |
| Adhesive Sika 32 without Primer                  |                              |                                       |                                 |  |                                    |  |
| N14  | 270.399                      | 372.1                                 | 0.002                           | 1.008                                    | 0.084                              | 100%S  |
| N15  | 282.337                      | 278.1                                 | 0.002                           | 1.379                                    | 0.151                              | 100%S  |
| N16*   | 291.342                      | 452.6                                 | 0.004                           | 3.530                                    | 0.192                              | 100%S  |
| Adhesive Sika 32 with Primer Sika 55             |                              |                                       |                                 |  |                                    |  |
| N14P*  | 270.399                      | 390.9                                 | 0.001                           | 2.727                                    | 0.194                              | 100%S  |
| N15P   | 282.337                      | 340.3                                 | 0.002                           | 0.532                                    | 0.06                               | 100%S  |
| N16P   | 291.342                      | 411.4                                 | 0.025                           | 1.651                                    | 0.139                              | 100%S  |
| Adhesive Madewell 1312F without Primer           |                              |                                       |                                 |  |                                    |  |
| N17  | 281.962                      | 212.6                                 | 0.005                           | 0.609                                    | 0.104                              | 100%S  |
| N18*   | 291.696                      | 315.2                                 | 0.001                           | 1.746                                    | 0.159                              | 100%S  |
| N19  | 281.738                      | 243.2                                 | 0.005                           | 0.891                                    | 0.146                              | 100%S  |
| Adhesive Madewell 1312F with Primer Madewell 927 |                              |                                       |                                 |  |                                    |  |
| N17P   | 281.962                      | 244.2                                 | 0.001                           | 1.937                                    | 0.159                              | 100%S  |
| N18P*  | 291.696                      | 329.4                                 | 0.008                           | 2.097                                    | 0.183                              | 100%S  |
| N19P   | 281.738                      | 183.4                                 | 0.002                           | 0.982                                    | 0.119                              | 100%S  |

Table 2. Set #2 – Temperature 70°F, Relative Humidity 65%.

| TEST   | Mass of Mortar Cube<br>grams | Peak Load to pull off dolly<br>pounds | Adhesive Film Thickness<br>inch | Mass of Mortar Layer pulled off<br>grams | Max Height of Mortar Layer<br>inch | Type of Failure<br>S=substrate<br>A=adhesive<br>C=cohesive |
|--|------------------------------|---------------------------------------|---------------------------------|--|------------------------------------|--|
| Adhesive Sika 30 without Primer                  |                              |                                       |                                 |  |                                    |  |
| N21  | 274.124                      | 108.2                                 | 0.011                           | 0.618                                    | 0.149                              | 100%S  |
| N22  | 264.988                      | 280.9                                 | 0.005                           | 0.771                                    | 0.234                              | 90%S+10%A  |
| N23  | 288.71                       | 276.2                                 | 0.014                           | 0.550                                    | 0.051                              | 95%S+5%A   |
| Adhesive Sika 30 with Primer Sika 55             |                              |                                       |                                 |  |                                    |  |
| N21P*  | 274.124                      | 235                                   | 0.011                           | 1.882                                    | 0.144                              | 100%S  |
| N22P   | 264.988                      | 113.4                                 | 0.013                           | 1.033                                    | 0.129                              | 95%S+5%A   |
| N23P   | 288.71                       | 187.4                                 | 0.009                           | 0.430                                    | 0.050                              | 10%S+90%A  |
| Adhesive Sika 32 without Primer                  |                              |                                       |                                 |  |                                    |  |
| N24  | 287.947                      | 276.2                                 | 0.010                           | 0.638                                    | 0.100                              | 100%S  |
| N25  | 285.454                      | 403.1                                 | 0.003                           | 0.405                                    | 0.034                              | 100%S  |
| N26  | 286.765                      | 359.9                                 | 0.008                           | 0.636                                    | 0.044                              | 100%S  |
| Adhesive Sika 32 with Primer Sika 55             |                              |                                       |                                 |  |                                    |  |
| N24P   | 287.947                      | 301.5                                 | 0.008                           | 0.705                                    | 0.059                              | 100%S  |
| N25P   | 285.454                      | 293.6                                 | 0.008                           | 0.447                                    | 0.054                              | 95%S+5%A   |
| N26P*  | 286.765                      | 436                                   | 0.004                           | 1.814                                    | 0.165                              | 100%S  |
| Adhesive Madewell 1312F without Primer           |                              |                                       |                                 |  |                                    |  |
| N27-SL   | 286.433                      | 149.4                                 | 0.005                           | 0.497                                    | 0.091                              | 90%S+10%A  |
| N28  | 265.607                      | 161.3                                 | 0.012                           | 1.011                                    | 0.164                              | 100%S  |
| N29  | 276.982                      | 267.2                                 | 0.006                           | 1.114                                    | 0.168                              | 100%S  |
| Adhesive Madewell 1312F with Primer Madewell 927 |                              |                                       |                                 |  |                                    |  |
| N27P   | 286.433                      | 306                                   | 0.006                           | 1.448                                    | 0.129                              | 100%S  |
| N28P*  | 265.607                      | 167.3                                 | 0.005                           | 1.85                                     | 0.161                              | 100%S  |
| N29P*  | 276.982                      | 233.6                                 | 0.007                           | 2.103                                    | 0.159                              | 100%S  |

Table 3. Set #3 – Temperature 70°F, Relative Humidity 80%.

| TEST   | Mass of Mortar Cube<br>grams | Peak Load to pull off dolly<br>pounds | Adhesive Film Thickness<br>inch | Pulled off Mass of Mortar Layer<br>grams | Max Height of Mortar Layer<br>inch | Type of Failure<br>S=substrate<br>A=adhesive<br>C=cohesive |
|--|------------------------------|---------------------------------------|---------------------------------|--|------------------------------------|--|
| Adhesive Sika 30 without Primer                  |                              |                                       |                                 |  |                                    |  |
| N31  | 279.708                      | 223.4                                 | 0.010                           | 0.320                                    | 0.097                              | 20%A+80%S  |
| N32  | 284.493                      | 187                                   | 0.009                           | 1.385                                    | 0.154                              | 98%S+20%A  |
| N33  | 275.726                      | 167.9                                 | 0.003                           | 1.119                                    | 0.124                              | 95%S+5%A   |
| Adhesive Sika 30 with Primer Sika 55             |                              |                                       |                                 |  |                                    |  |
| N31P   | 279.708                      | 91.11                                 | 0.008                           | 0.155                                    | 0.019                              | 10%S+90%A  |
| N32P   | 284.493                      | 23                                    | 0.009                           | 0.461                                    | 0.080                              | 66%S+34%A  |
| N33P   | 275.726                      | 66.47                                 | 0.008                           | 0.223                                    | 0.052                              | 20%S+80%A  |
| Adhesive Sika 32 without Primer                  |                              |                                       |                                 |  |                                    |  |
| N34  | 286.264                      | 268.7                                 | 0.002                           | 1.121                                    | 0.105                              | 100%S  |
| N35  | 283.979                      | 287.4                                 | 0.01                            | 1.060                                    | 0.108                              | 100%S  |
| N36  | 285.642                      | 221.2                                 | 0.003                           | 1.409                                    | 0.130                              | 100%S  |
| Adhesive Sika 32 with Primer Sika 55             |                              |                                       |                                 |  |                                    |  |
| N34P   | 286.264                      | 280.9                                 | 0.006                           | 0.876                                    | 0.094                              | 100%S  |
| N35P   | 283.979                      | 268.3                                 | 0.004                           | 0.866                                    | 0.099                              | 100%S  |
| N36P   | 285.642                      | 390.6                                 | 0.003                           | 0.345                                    | 0.055                              | 100%S  |
| Adhesive Madewell 1312F without Primer           |                              |                                       |                                 |  |                                    |  |
| N37  | 280.439                      | 184.3                                 | 0.005                           | 0.731                                    | 0.088                              | 100%S  |
| N38  | 288.469                      | 136                                   | 0.002                           | 0.374                                    | 0.064                              | 98%S+2%A   |
| N39  | 270.004                      | 128.5                                 | 0.002                           | 0.845                                    | 0.151                              | 95%S+5%A   |
| Adhesive Madewell 1312F with Primer Madewell 927 |                              |                                       |                                 |  |                                    |  |
| N37P   | 280.439                      | 261.2                                 | 0.004                           | 0.876                                    | 0.109                              | 100%S  |
| N38P   | 288.469                      | 298.5                                 | 0.004                           | 0.809                                    | 0.084                              | 100%S  |
| N39P   | 270.004                      | 194.2                                 | 0.004                           | 1.221                                    | 0.117                              | 100%S  |

Table 4. Set #4 – Temperature 70°F, Relative Humidity 95%.

| TEST   | Mass of<br>Mortar Cube<br>grams | Peak Load to<br>pull off dolly<br>pounds | Adhesive Film<br>Thickness<br>inch | Pulled off Mass<br>of Mortar Layer<br>grams | Max Height of<br>Mortar Layer<br>inch | Type of Failure<br>S=substrate<br>A=adhesive<br>C=cohesive |
|--|---------------------------------|--|------------------------------------|---|---------------------------------------|--|
| Adhesive Sika 30 without Primer                  |                                 |  |                                    |   |                                       |  |
| N41  | 285.319                         | 336.8                                    | 0.014                              | 0.282                                       | 0.052                                 | 15%S+85%A  |
| N42  | 276.686                         | 88.19                                    | 0.006                              | 0.315                                       | 0.045                                 | 10%S+90%A  |
| N43  | 290.384                         | 143.2                                    | 0.019                              | 0.975                                       | 0.109                                 | 95%S+5%A   |
| Adhesive Sika 30 with Primer Sika 55             |                                 |  |                                    |   |                                       |  |
| N41P   | 285.319                         | 144.1                                    | 0.015                              | 0.481                                       | 0.059                                 | 90%S+10%A  |
| N42P   | 276.686                         | 134.9                                    | 0.004                              | 0.285                                       | 0.062                                 | 50%S+50%A  |
| N43P   | 290.384                         | 156.3                                    | 0.008                              | 0.825                                       | 0.114                                 | 40%S+60%A  |
| Adhesive Sika 32 without Primer                  |                                 |  |                                    |   |                                       |  |
| N44  | 286.217                         | 355.8                                    | 0.004                              | 0.521                                       | 0.053                                 | 100%S  |
| N45*   | 279.680                         | 242.5                                    | 0.002                              | 1.887                                       | 0.149                                 | 100%S  |
| N46*   | 273.337                         | 200.7                                    | 0.003                              | 1.998                                       | 0.219                                 | 100%S  |
| Adhesive Sika 32 with Primer Sika 55             |                                 |  |                                    |   |                                       |  |
| N44P   | 286.217                         | 306.2                                    | 0.003                              | 1.082                                       | 0.122                                 | 100%S  |
| N45P   | 279.680                         | 314.6                                    | 0.002                              | 0.846                                       | 0.094                                 | 100%S  |
| N46P   | 273.337                         | 297.7                                    | 0.004                              | 1.405                                       | 0.178                                 | 100%S  |
| Adhesive Madewell 1312F without Primer           |                                 |  |                                    |   |                                       |  |
| N47  | 278.662                         | 200.7                                    | 0.009                              | 0.892                                       | 0.118                                 | 96%S+4%A   |
| N48  | 289.921                         | 315.4                                    | 0.009                              | 0.838                                       | 0.089                                 | 100%S  |
| N49  | 281.559                         | 229.8                                    | 0.005                              | 1.422                                       | 0.169                                 | 100%S  |
| Adhesive Madewell 1312F with Primer Madewell 927 |                                 |  |                                    |   |                                       |  |
| N47P   | 278.662                         | 304.2                                    | 0.005                              | 1.272                                       | 0.132                                 | 100%S  |
| N48P*  | 289.921                         | 369                                      | 0.004                              | 1.924                                       | 0.139                                 | 100%S  |
| N49P   | 281.559                         | 264.2                                    | 0.004                              | 1.189                                       | 0.096                                 | 100%S  |

Table 5. Set #5 – Temperature 85°F, Relative Humidity 50%.

| TEST   | Mass of Mortar Cube<br>grams | Peak Load to pull off dolly<br>pounds | Adhesive Film Thickness<br>inch | Pulled off Mass of Mortar Layer<br>grams | Max Height of Mortar Layer<br>inch | Type of Failure<br>S=substrate<br>A=adhesive<br>C=cohesive |
|--|------------------------------|---------------------------------------|---------------------------------|--|------------------------------------|--|
| Adhesive Sika 30 without Primer                  |                              |                                       |                                 |  |                                    |  |
| N51X   | 280.141                      | 0                                     | 0.016                           | 0.866                                    | 0.118                              | 85%S+15%A  |
| N52  | 281.79                       | 161.1                                 | 0.010                           | 0.976                                    | 0.074                              | 80%S+20%A  |
| N53  | 276.78                       | 82.5                                  | 0.030                           | 0.978                                    | 0.059                              | 70%S+30%A  |
| Adhesive Sika 30 with Primer Sika 55             |                              |                                       |                                 |  |                                    |  |
| N51P   | 280.141                      | 130.4                                 | 0.035                           | 1.330                                    | 0.102                              | 98%S+2%A   |
| N52P   | 281.79                       | 91.6                                  | 0.012                           | 0.942                                    | 0.093                              | 75%S+25%A  |
| N53P   | 276.78                       | 181.6                                 | 0.019                           | 0.879                                    | 0.069                              | 80%S+20%A  |
| Adhesive Sika 32 without Primer                  |                              |                                       |                                 |  |                                    |  |
| N54  | 281.776                      | 332.8                                 | 0.013                           | 0.725                                    | 0.042                              | 100%S  |
| N55  | 279.558                      | 273.8                                 | 0.017                           | 0.837                                    | 0.064                              | 100%S  |
| N56  | 288.795                      | 317.7                                 | 0.003                           | 1.147                                    | 0.112                              | 100%S  |
| Adhesive Sika 32 with Primer Sika 55             |                              |                                       |                                 |  |                                    |  |
| N54P   | 281.776                      | 389                                   | 0.003                           | 0.913                                    | 0.079                              | 100%S  |
| N55P*  | 279.558                      | 252.8                                 | 0.005                           | 1.686                                    | 0.099                              | 100%S  |
| N56P*  | 288.795                      | 483.8                                 | 0.005                           | 1.677                                    | 0.124                              | 100%S  |
| Adhesive Madewell 1312F without Primer           |                              |                                       |                                 |  |                                    |  |
| N57  | 287.163                      | 406.7                                 | 0.004                           | 0.561                                    | 0.062                              | 98%S+2%A   |
| N58  | 290.875                      | 291.5                                 | 0.005                           | 0.525                                    | 0.067                              | 100%S  |
| N59  | 288.471                      | 170                                   | 0.005                           | 0.396                                    | 0.043                              | 100%S  |
| Adhesive Madewell 1312F with Primer Madewell 927 |                              |                                       |                                 |  |                                    |  |
| N57PX  | 287.163                      | 0                                     | 0.006                           | 0.085                                    | 0.090                              | 100%A  |
| N58P   | 290.875                      | 458.3                                 | 0.004                           | 0.633                                    | 0.075                              | 98%S+2%A   |
| N59P   | 288.471                      | 330.3                                 | 0.003                           | 1.270                                    | 0.123                              | 100%S  |

Table 6. Set #6 – Temperature 85°F, Relative Humidity 65%.

| TEST   | Mass of<br>Mortar Cube<br>grams | Peak Load to<br>pull off dolly<br>pounds | Adhesive Film<br>Thickness<br>inch | Pulled off Mass<br>of Mortar Layer<br>grams | Max Height of<br>Mortar Layer<br>inch | Type of Failure<br>S=substrate<br>A=adhesive<br>C=cohesive |
|--|---------------------------------|--|------------------------------------|---|---------------------------------------|--|
| Adhesive Sika 30 without Primer                  |                                 |  |                                    |   |                                       |  |
| N61*   | 292.429                         | 237.6                                    | 0.007                              | 1.686                                       | 0.173                                 | 100%S  |
| N62  | 288.232                         | 180.2                                    | 0.008                              | 1.135                                       | 0.126                                 | 90%S+10%A  |
| N63  | 282.199                         | 280.9                                    | 0.016                              | 1.157                                       | 0.141                                 | 100%S  |
| Adhesive Sika 30 with Primer Sika 55             |                                 |  |                                    |   |                                       |  |
| N61P   | 292.429                         | 98.5                                     | 0.013                              | 0.220                                       | 0.055                                 | 20%S+80%A  |
| N62P   | 288.232                         | 178.7                                    | 0.021                              | 0.881                                       | 0.114                                 | 90%S+10%A  |
| N63P   | 282.199                         | 198.9                                    | 0.009                              | 0.287                                       | 0.141                                 | 60%S+40%A  |
| Adhesive Sika 32 without Primer                  |                                 |  |                                    |   |                                       |  |
| N64  | 291.673                         | 394.6                                    | 0.002                              | 1.032                                       | 0.114                                 | 100%S  |
| N65  | 289.440                         | 232.8                                    | 0.003                              | 1.301                                       | 0.104                                 | 100%S  |
| N66*   | 288.040                         | 281.3                                    | 0.004                              | 2.027                                       | 0.159                                 | 100%S  |
| Adhesive Sika 32 with Primer Sika 55             |                                 |  |                                    |   |                                       |  |
| N64P   | 291.673                         | 312.6                                    | 0.006                              | 0.907                                       | 0.083                                 | 90%S+10%A  |
| N65P*  | 289.440                         | 303.2                                    | 0.009                              | 1.697                                       | 0.129                                 | 98%S+2%A   |
| N66P   | 288.040                         | 319.9                                    | 0.004                              | 1.380                                       | 0.147                                 | 100%S  |
| Adhesive Madewell 1312F without Primer           |                                 |  |                                    |   |                                       |  |
| N67*   | 289.809                         | 277.9                                    | 0.011                              | 2.105                                       | 0.207                                 | 100%S  |
| N68 SL   | 286.662                         | 253.7                                    | 0.009                              | 0.411                                       | 0.061                                 | 75%S+25%A  |
| N69  | 292.428                         | 223.2                                    | 0.004                              | 0.922                                       | 0.124                                 | 100%S  |
| Adhesive Madewell 1312F with Primer Madewell 927 |                                 |  |                                    |   |                                       |  |
| N67P*  | 289.809                         | 256                                      | 0.002                              | 1.731                                       | 0.144                                 | 100%S  |
| N68P   | 286.662                         | 259.1                                    | 0.008                              | 0.747                                       | 0.083                                 | 100%S  |
| N69P   | 292.428                         | 329.1                                    | 0.007                              | 0.908                                       | 0.094                                 | 100%S  |

Table 7. Set #7 – Temperature 85°F, Relative Humidity 80%.

| TEST   | Mass of Mortar Cube<br>grams | Peak Load to pull off dolly<br>pounds | Adhesive Film Thickness<br>inch | Pulled off Mass of Mortar Layer<br>grams | Max Height of Mortar Layer<br>inch | Type of Failure<br>S=substrate<br>A=adhesive<br>C=cohesive |
|--|------------------------------|---------------------------------------|---------------------------------|--|------------------------------------|--|
| Adhesive Sika 30 without Primer                  |                              |                                       |                                 |  |                                    |  |
| N71  | 290.506                      | 297.9                                 | 0.026                           | 1.287                                    | 0.112                              | 100%S  |
| N72  | 289.865                      | 133.7                                 | 0.011                           | 0.535                                    | 0.097                              | 80%S+20%A  |
| N73  | 293.065                      | 180                                   | 0.005                           | 0.926                                    | 0.109                              | 98%S+2%A   |
| Adhesive Sika 30 with Primer Sika 55             |                              |                                       |                                 |  |                                    |  |
| N71P   | 290.506                      | 91.4                                  | 0.008                           | 0.245                                    | 0.056                              | 20%S+80%A  |
| N72P   | 289.865                      | 57.72                                 | 0.017                           | 0.420                                    | 0.069                              | 25%S+75%A  |
| N73P   | 293.065                      | 299.9                                 | 0.029                           | 0.814                                    | 0.097                              | 100%S  |
| Adhesive Sika 32 without Primer                  |                              |                                       |                                 |  |                                    |  |
| N74  | 281.978                      | 409.5                                 | 0.005                           | 0.473                                    | 0.045                              | 100%S  |
| N75*   | 292.584                      | 340.1                                 | 0.007                           | 3.947                                    | 0.239                              | 100%S  |
| N76  | 286.958                      | 394.5                                 | 0.005                           | 0.451                                    | 0.046                              | 95%S+5%A   |
| Adhesive Sika 32 with Primer Sika 55             |                              |                                       |                                 |  |                                    |  |
| N74P   | 281.978                      | 405.1                                 | 0.006                           | 0.508                                    | 0.084                              | 90%S+10%A  |
| N75P*  | 292.584                      | 439.2                                 | 0.009                           | 2.135                                    | 0.171                              | 95%S+5%A   |
| N76P*  | 286.958                      | 373.7                                 | 0.005                           | 2.640                                    | 0.220                              | 100%S  |
| Adhesive Madewell 1312F without Primer           |                              |                                       |                                 |  |                                    |  |
| N77  | 285.693                      | 381.5                                 | 0.005                           | 0.798                                    | 0.107                              | 100%S  |
| N78*   | 292.739                      | 320.8                                 | 0.003                           | 1.557                                    | 0.112                              | 100%S  |
| N79  | 283.421                      | 375.4                                 | 0.007                           | 0.670                                    | 0.094                              | 100%S  |
| Adhesive Madewell 1312F with Primer Madewell 927 |                              |                                       |                                 |  |                                    |  |
| N77P   | 285.693                      | 438.3                                 | 0.008                           | 0.471                                    | 0.059                              | 100%S  |
| N78P   | 292.739                      | 258.3                                 | 0.003                           | 0.843                                    | 0.100                              | 100%S  |
| N79P   | 283.421                      | 393.6                                 | 0.003                           | 0.519                                    | 0.065                              | 100%S  |

Table 8. Set #8 – Temperature 85°F, Relative Humidity 95%.

| TEST   | Mass of Mortar Cube<br>grams | Peak Load to pull off dolly<br>pounds | Adhesive Film Thickness<br>inch | Pulled off Mass of Mortar Layer<br>grams | Max Height of Mortar Layer<br>inch | Type of Failure<br>S=substrate<br>A=adhesive<br>C=cohesive |
|--|------------------------------|---------------------------------------|---------------------------------|--|------------------------------------|--|
| Adhesive Sika 30 without Primer                  |                              |                                       |                                 |  |                                    |  |
| N81  | 284.219                      | 116.9                                 | 0.020                           | 0.633                                    | 0.089                              | 90%S+10%A  |
| N82  | 285.349                      | 271.3                                 | 0.024                           | 0.585                                    | 0.050                              | 100%S  |
| N83  | 282.322                      | 167.300                               | 0.014                           | 1.202                                    | 0.144                              | 98%S+2%A   |
| Adhesive Sika 30 with Primer Sika 55             |                              |                                       |                                 |  |                                    |  |
| N81P   | 284.219                      | 101.2                                 | 0.015                           | 0.727                                    | 0.119                              | 90%S+10%A  |
| N82P   | 285.349                      | 301.7                                 | 0.018                           | 0.435                                    | 0.049                              | 100%S  |
| N83P   | 282.322                      | 287.4                                 | 0.013                           | 0.670                                    | 0.112                              | 90%S+10%A  |
| Adhesive Sika 32 without Primer                  |                              |                                       |                                 |  |                                    |  |
| N84  | 291.642                      | 330.1                                 | 0.007                           | 1.240                                    | 0.1                                | 100%S  |
| N85  | 294.170                      | 335.4                                 | 0.003                           | 1.395                                    | 0.089                              | 100%S  |
| N86  | 288.356                      | 326.3                                 | 0.003                           | 1.512                                    | 0.114                              | 100%S  |
| Adhesive Sika 32 with Primer Sika 55             |                              |                                       |                                 |  |                                    |  |
| N84P*  | 291.642                      | 318                                   | 0.003                           | 2.227                                    | 0.189                              | 100%S  |
| N85P*  | 294.170                      | 280.9                                 | 0.005                           | 1.514                                    | 0.114                              | 100%S  |
| N86P*  | 288.356                      | 270.6                                 | 0.003                           | 1.697                                    | 0.171                              | 100%S  |
| Adhesive Madewell 1312F without Primer           |                              |                                       |                                 |  |                                    |  |
| N87 SL   | 290.119                      | 231.5                                 | 0.005                           | 1.105                                    | 0.140                              | 100%S  |
| N88  | 292.453                      | 231.8                                 | 0.007                           | 0.815                                    | 0.104                              | 95%S+5%A   |
| N89 SL   | 291.940                      | 307.4                                 | 0.003                           | 1.070                                    | 0.127                              | 100%S  |
| Adhesive Madewell 1312F with Primer Madewell 927 |                              |                                       |                                 |  |                                    |  |
| N87P   | 290.119                      | 332.1                                 | 0.004                           | 1.410                                    | 0.126                              | 100%S  |
| N88P   | 292.453                      | 337.6                                 | 0.009                           | 1.000                                    | 0.114                              | 100%S  |
| N89P*  | 291.940                      | 370.6                                 | 0.004                           | 2.720                                    | 0.199                              | 100%S  |



Table 9. Set #9 – Temperature 100°F, Relative Humidity 50%.

| TEST   | Mass of Mortar Cube grams | Peak Load to pull off dolly pounds | Adhesive Film Thickness inch | Pulled off Mass of Mortar Layer grams | Max Height of Mortar Layer inch | Type of Failure<br>S=substrate<br>A=adhesive<br>C=cohesive |
|--|---------------------------|------------------------------------|------------------------------|---------------------------------------|---------------------------------|--|
| Adhesive Sika 30 without Primer                  |                           |                                    |                              |                                       |                                 |  |
| N91  | 287.858                   | 147.2                              | 0.008                        | 0.349                                 | 0.061                           | 60%S+40%A  |
| N92  | 289.315                   | 212.3                              | 0.012                        | 0.618                                 | 0.060                           | 100%S  |
| N93  | 282.628                   | 134.5                              | 0.012                        | 0.555                                 | 0.189                           | 80%S+20%A  |
| Adhesive Sika 30 with Primer Sika 55             |                           |                                    |                              |                                       |                                 |  |
| N91P   | 287.858                   | 65.48                              | 0.014                        | 0.302                                 | 0.057                           | 30%S+70%A  |
| N92P   | 289.315                   | 117.2                              | 0.010                        | 0.700                                 | 0.076                           | 95%S+5%A   |
| N93P   | 282.628                   | 204.8                              | 0.011                        | 0.530                                 | 0.055                           | 95%S+5%A   |
| Adhesive Sika 32 without Primer                  |                           |                                    |                              |                                       |                                 |  |
| N94*   | 280.561                   | 322.5                              | 0.004                        | 1.715                                 | 0.161                           | 100%S  |
| N95  | 283.215                   | 300.9                              | 0.002                        | 0.445                                 | 0.034                           | 100%S  |
| N96  | 279.572                   | 302                                | 0.004                        | 0.423                                 | 0.049                           | 100%S  |
| Adhesive Sika 32 with Primer Sika 55             |                           |                                    |                              |                                       |                                 |  |
| N94P   | 280.561                   | 341.6                              | 0.005                        | 0.440                                 | 0.040                           | 100%S  |
| N95P*  | 283.215                   | 319.5                              | 0.004                        | 2.075                                 | 0.214                           | 100%S  |
| N96P   | 279.572                   | 348.7                              | 0.003                        | 0.489                                 | 0.066                           | 100%S  |
| Adhesive Madewell 1312F without Primer           |                           |                                    |                              |                                       |                                 |  |
| N97R   | 280.561                   | 352.0                              | 0.005                        | 0.497                                 | 0.070                           | 98%S+2%A   |
| N98R   | 283.215                   | 277.0                              | 0.004                        | 0.509                                 | 0.085                           | 100S   |
| N99R   | 279.572                   | 453.0                              | 0.002                        | 0.468                                 | 0.060                           | 100%   |
| Adhesive Madewell 1312F with Primer Madewell 927 |                           |                                    |                              |                                       |                                 |  |
| N97PR  | 286.211                   | 428.200                            | 0.003                        | 0.969                                 | 0.135                           | 100%   |
| N98PR  | 281.546                   | 468.000                            | 0.009                        | 0.642                                 | 0.095                           | 100%   |
| N99PR  | 290.306                   | 412.800                            | 0.003                        | 0.236                                 | 0.057                           | 98%S+2%A   |

Table 10. Set #10 – Temperature 100°F, Relative Humidity 65%.

| TEST   | Mass of<br>Mortar Cube<br>grams | Peak Load to<br>pull off dolly<br>pounds | Adhesive Film<br>Thickness<br>inch | Pulled off Mass<br>of Mortar Layer<br>grams | Max Height of<br>Mortar Layer<br>inch | Type of Failure<br>S=substrate<br>A=adhesive<br>C=cohesive |
|--|---------------------------------|--|------------------------------------|---|---------------------------------------|--|
| Adhesive Sika 30 without Primer                  |                                 |  |                                    |   |                                       |  |
| N101   | 307.138                         | 129.4                                    | 0.010                              | 0.395                                       | 0.055                                 | 70%S+30%A  |
| N102   | 293.312                         | 164.1                                    | 0.012                              | 0.590                                       | 0.071                                 | 95%S+5%A   |
| N103   | 304.477                         | 213.7                                    | 0.009                              | 1.163                                       | 0.122                                 | 100%S  |
| Adhesive Sika 30 with Primer Sika 55             |                                 |  |                                    |   |                                       |  |
| N101P  | 307.138                         | 102                                      | 0.015                              | 0.385                                       | 0.066                                 | 70%S+30%A  |
| N102P  | 293.312                         | 93.93                                    | 0.012                              | 0.597                                       | 0.073                                 | 90%S+10%A  |
| N103P  | 304.477                         | 311.8                                    | 0.011                              | 0.900                                       | 0.114                                 | 95%S+5%A   |
| Adhesive Sika 32 without Primer                  |                                 |  |                                    |   |                                       |  |
| N104   | 301.486                         | 403.9                                    | 0.003                              | 0.725                                       | 0.090                                 | 100%S  |
| N105*  | 289.653                         | 276.9                                    | 0.004                              | 3.110                                       | 0.245                                 | 100%S  |
| N106   | 298.328                         | 329.1                                    | 0.010                              | 0.982                                       | 0.114                                 | 98%S+2%A   |
| Adhesive Sika 32 with Primer Sika 55             |                                 |  |                                    |   |                                       |  |
| N104P  | 301.486                         | 382                                      | 0.005                              | 0.732                                       | 0.085                                 | 100%S  |
| N105P  | 289.653                         | 313.6                                    | 0.005                              | 0.750                                       | 0.081                                 | 100%S  |
| N106P  | 298.328                         | 305.8                                    | 0.006                              | 0.565                                       | 0.054                                 | 98%S+2%A   |
| Adhesive Madewell 1312F without Primer           |                                 |  |                                    |   |                                       |  |
| N107   | 287.550                         | 243.8                                    | 0.003                              | 0.33  | 0.069                                 | 95%S+5%A   |
| N108*  | 285.745                         | 320.4                                    | 0.004                              | 1.565                                       | 0.168                                 | 100%S  |
| N109   | 287.488                         | 342.7                                    | 0.003                              | 0.552                                       | 0.072                                 | 100%S  |
| Adhesive Madewell 1312F with Primer Madewell 927 |                                 |  |                                    |   |                                       |  |
| N107P  | 287.550                         | 292.2                                    | 0.03                               | 0.530                                       | 0.067                                 | 95%S+5%A   |
| N108P  | 285.745                         | 312.5                                    | 0.002                              | 0.270                                       | 0.090                                 | 40%S+60%A  |
| N109P  | 287.488                         | 327.9                                    | 0.004                              | 0.619                                       | 0.075                                 | 100%S  |

Table 11. Set #11 – Temperature 100°F, Relative Humidity 80%.

| TEST   | Mass of Mortar Cube<br>grams | Peak Load to pull off dolly<br>pounds | Adhesive Film Thickness<br>inch | Pulled off Mass of Mortar Layer<br>grams | Max Height of Mortar Layer<br>inch | Type of Failure<br>S=substrate<br>A=adhesive<br>C=cohesive |
|--|------------------------------|---------------------------------------|---------------------------------|--|------------------------------------|--|
| Adhesive Sika 30 without Primer                  |                              |                                       |                                 |  |                                    |  |
| N111   | 288.235                      | 269                                   | 0.018                           | 1.100                                    | 0.116                              | 100%S  |
| N112   | 288.365                      | 144.9                                 | 0.012                           | 0.435                                    | 0.073                              | 70%S+30%A  |
| N113   | 297.109                      | 113                                   | 0.018                           | 0.635                                    | 0.124                              | 60%S+40%A  |
| Adhesive Sika 30 with Primer Sika 55             |                              |                                       |                                 |  |                                    |  |
| N111P  | 288.235                      | 223.8                                 | 0.008                           | 0.733                                    | 0.091                              | 60%S+40%A  |
| N112P  | 288.365                      | 189.5                                 | 0.011                           | 0.250                                    | 0.043                              | 5%S+95%A   |
| N113P  | 297.109                      | 309                                   | 0.012                           | 0.625                                    | 0.074                              | 97%S+3%A   |
| Adhesive Sika 32 without Primer                  |                              |                                       |                                 |  |                                    |  |
| N114   | 292.419                      | 315.2                                 | 0.006                           | 1.230                                    | 0.163                              | 100%S  |
| N115   | 297.120                      | 294.9                                 | 0.004                           | 0.250                                    | 0.034                              | 100%S(thin lyr)  |
| N116   | 305.989                      | 259.3                                 | 0.009                           | 0.252                                    | 0.018                              | 100%S(thin lyr)  |
| Adhesive Sika 32 with Primer Sika 55             |                              |                                       |                                 |  |                                    |  |
| N114P  | 292.419                      | 288.2                                 | 0.008                           | 0.325                                    | 0.031                              | 50%S+50%A  |
| N115P  | 297.120                      | 331.5                                 | 0.008                           | 1.468                                    | 0.149                              | 100%S  |
| N116P  | 305.989                      | 445.9                                 | 0.006                           | 0.402                                    | 0.073                              | 100%S(thin lyr)  |
| Adhesive Madewell 1312F without Primer           |                              |                                       |                                 |  |                                    |  |
| N117   | 306.328                      | 429.4                                 | 0.004                           | 0.345                                    | 0.087                              | 75%S+25%A  |
| N118 SL  | 309.997                      | 265.1                                 | 0.005                           | 0.785                                    | 0.126                              | 100%S  |
| N119 SL  | 287.058                      | 194.5                                 | 0.003                           | 0.955                                    | 0.124                              | 100%S  |
| Adhesive Madewell 1312F with Primer Madewell 927 |                              |                                       |                                 |  |                                    |  |
| N117P  | 306.328                      | 287.1                                 | 0.007                           | 1.117                                    | 0.133                              | 100%S  |
| N118P  | 309.997                      | 371.9                                 | 0.008                           | 0.255                                    | 0.030                              | 100%S(thin lyr)  |
| N119P  | 287.058                      | 350.3                                 | 0.003                           | 0.630                                    | 0.074                              | 98%S+2%A   |

Table 12. Set #12 – Temperature 100°F, Relative Humidity 95%.

| TEST   | Mass of<br>Mortar Cube<br>grams | Peak Load to<br>pull off dolly<br>pounds | Adhesive Film<br>Thickness<br>inch | Pulled off Mass<br>of Mortar Layer<br>grams | Max Height of<br>Mortar Layer<br>inch | Type of Failure<br>S=substrate<br>A=adhesive<br>C=cohesive |
|--|---------------------------------|--|------------------------------------|---|---------------------------------------|--|
| Adhesive Sika 30 without Primer                  |                                 |  |                                    |   |                                       |  |
| N121*  | 302.726                         | 176.5                                    | 0.020                              | 1.628                                       | 0.177                                 | 100%S  |
| N122   | 300.294                         | 157.9                                    | 0.021                              | 0.268                                       | 0.067                                 | 10%S+90%A  |
| N123X  | 305.358                         | 0  | 0.012                              | 0.020                                       | 0.013                                 | 100%S  |
| Adhesive Sika 30 with Primer Sika 55             |                                 |  |                                    |   |                                       |  |
| N121P  | 302.726                         | 220.4                                    | 0.028                              | 0.538                                       | 0.108                                 | 90%S+10%A  |
| N122P  | 300.294                         | 250.1                                    | 0.016                              | 0.604                                       | 0.080                                 | 98%S+2%A   |
| N123P  | 305.358                         | 279.9                                    | 0.016                              | 0.335                                       | 0.059                                 | 70%S+30%A  |
| Adhesive Sika 32 without Primer                  |                                 |  |                                    |   |                                       |  |
| N124 SL  | 307.822                         | 63.03                                    | 0.02                               | 0.091                                       | 0.018                                 | 1%S+99%A   |
| N125 SL  | 289.640                         | 48.97                                    | 0.017                              | 0.040                                       | 0.012                                 | 100%C  |
| N126   | 305.451                         | 122.7                                    | 0.003                              | 0.086                                       | 0.038                                 | 5%S+95%A   |
| Adhesive Sika 32 with Primer Sika 55             |                                 |  |                                    |   |                                       |  |
| N124PX   | 307.822                         | 0  | 0.012                              | 0.100                                       | 0.020                                 | 100%A  |
| N125P  | 289.640                         | 86.07                                    | 0.027                              | 0.141                                       | 0.045                                 | 1%S+99%A   |
| N126P  | 305.451                         | 357.9                                    | 0.004                              | 0.350                                       | 0.065                                 | 90%S+10%A  |
| Adhesive Madewell 1312F without Primer           |                                 |  |                                    |   |                                       |  |
| N127X  | 290.985                         | 0  | 0.003                              | 0.002                                       | 0.004                                 | 100%A  |
| N128 SL  | 323.841                         | 111.8                                    | 0.011                              | 0.098                                       | 0.040                                 | 5%S+95%A   |
| N129 SL  | 298.946                         | 125.2                                    | 0.010                              | 0.068                                       | 0.068                                 | 2%S+98%A   |
| Adhesive Madewell 1312F with Primer Madewell 927 |                                 |  |                                    |   |                                       |  |
| N127P*   | 290.985                         | 209                                      | 0.003                              | 1.608                                       | 0.273                                 | 100%S  |
| N128P  | 323.841                         | 364.2                                    | 0.009                              | 0.295                                       | 0.081                                 | 20%S+80%A  |
| N129P  | 298.946                         | 359.3                                    | 0.017                              | 0.053                                       | 0.053                                 | 50%S+50%A  |

Table 13. Adhesive Sika 30 at Temperature 70°F.

| TEST                | Mass of Mortar Cube<br>grams | Peak Load to pull off dolly<br>pounds | Adhesive Film Thickness<br>inch | Pulled off Mass of Mortar Layer<br>grams | Max Height of Mortar Layer<br>inch | Type of Failure<br>S=substrate<br>A=adhesive<br>C=cohesive |
|---------------------|------------------------------|---------------------------------------|---------------------------------|--|------------------------------------|--|
| RH=50               |                              |                                       |                                 |  |                                    |  |
| Without Primer      |                              |                                       |                                 |  |                                    |  |
| N11                 | 280.312                      | 168.3                                 | 0.012                           | 0.573                                    | 0.058                              | 100%S  |
| N12                 | 279.058                      | 321                                   | 0.008                           | 0.716                                    | 0.104                              | 100%S  |
| N13*                | 275.824                      | 275.2                                 | 0.012                           | 2.639                                    | 0.199                              | 100%S  |
| With Primer Sika 55 |                              |                                       |                                 |  |                                    |  |
| N11P                | 280.312                      | 223                                   | 0.020                           | 0.594                                    | 0.077                              | 100%S  |
| N12P*               | 279.058                      | 297.7                                 | 0.010                           | 2.595                                    | 0.179                              | 100%S  |
| N13P*               | 275.824                      | 332.9                                 | 0.007                           | 3.087                                    | 0.213                              | 100%S  |
| RH=65               |                              |                                       |                                 |  |                                    |  |
| Without Primer      |                              |                                       |                                 |  |                                    |  |
| N21                 | 274.124                      | 108.2                                 | 0.011                           | 0.618                                    | 0.149                              | 100%S  |
| N22                 | 264.988                      | 280.9                                 | 0.005                           | 0.771                                    | 0.234                              | 90%S+10%A  |
| N23                 | 288.71                       | 276.2                                 | 0.014                           | 0.550                                    | 0.051                              | 95%S+5%A   |
| With Primer Sika 55 |                              |                                       |                                 |  |                                    |  |
| N21P*               | 274.124                      | 235                                   | 0.011                           | 1.882                                    | 0.144                              | 100%S  |
| N22P                | 264.988                      | 113.4                                 | 0.013                           | 1.033                                    | 0.129                              | 95%S+5%A   |
| N23P                | 288.71                       | 187.4                                 | 0.009                           | 0.430                                    | 0.050                              | 10%S+90%A  |
| RH=80               |                              |                                       |                                 |  |                                    |  |
| Without Primer      |                              |                                       |                                 |  |                                    |  |
| N31                 | 279.708                      | 223.4                                 | 0.010                           | 0.320                                    | 0.097                              | 20%A+80%S  |
| N32                 | 284.493                      | 187                                   | 0.009                           | 1.385                                    | 0.154                              | 98%S+20%A  |
| N33                 | 275.726                      | 167.9                                 | 0.003                           | 1.119                                    | 0.124                              | 95%S+5%A   |
| With Primer Sika 55 |                              |                                       |                                 |  |                                    |  |
| N31P                | 279.708                      | 91.11                                 | 0.008                           | 0.155                                    | 0.019                              | 10%S+90%A  |
| N32PX               | 284.493                      | 0                                     | 0.009                           | 0.461                                    | 0.080                              | 66%S+34%A  |
| N33P                | 275.726                      | 166.47                                | 0.008                           | 0.223                                    | 0.052                              | 20%S+80%A  |
| RH=95               |                              |                                       |                                 |  |                                    |  |
| Without Primer      |                              |                                       |                                 |  |                                    |  |
| N41                 | 285.319                      | 336.8                                 | 0.014                           | 0.282                                    | 0.052                              | 15%S+85%A  |
| N42                 | 276.686                      | 88.19                                 | 0.006                           | 0.315                                    | 0.045                              | 10%S+90%A  |
| N43                 | 290.384                      | 143.2                                 | 0.019                           | 0.975                                    | 0.109                              | 95%S+5%A   |
| With Primer Sika 55 |                              |                                       |                                 |  |                                    |  |
| N41P                | 285.319                      | 144.1                                 | 0.015                           | 0.481                                    | 0.059                              | 90%S+10%A  |
| N42P                | 276.686                      | 134.9                                 | 0.004                           | 0.285                                    | 0.062                              | 50%S+50%A  |
| N43P                | 290.384                      | 156.3                                 | 0.008                           | 0.825                                    | 0.114                              | 40%S+60%A  |

Table 13A. Adhesive Sika 30 at Temperature 70°F.

| TEST                | Mass of Mortar Cube<br>grams | Peak Load to pull off dolly<br>pounds | Adhesive Film Thickness<br>inch | Pulled off Mass of Mortar Layer<br>grams | Max Height of Mortar Layer<br>inch | Type of Failure<br>S=substrate<br>A=adhesive<br>C=cohesive |
|---------------------|------------------------------|---------------------------------------|---------------------------------|--|------------------------------------|--|
| Without Primer      |                              |                                       |                                 |  |                                    |  |
| RH=50%              |                              |                                       |                                 |  |                                    |  |
| N11                 | 280.312                      | 168.3                                 | 0.012                           | 0.573                                    | 0.058                              | 100%S  |
| N12                 | 279.058                      | 321                                   | 0.008                           | 0.716                                    | 0.104                              | 100%S  |
| N13*                | 275.824                      | 275.2                                 | 0.012                           | 2.639                                    | 0.199                              | 100%S  |
| RH=65%              |                              |                                       |                                 |  |                                    |  |
| N21                 | 274.124                      | 108.2                                 | 0.011                           | 0.618                                    | 0.149                              | 100%S  |
| N22                 | 264.988                      | 280.9                                 | 0.005                           | 0.771                                    | 0.234                              | 90%S+10%A  |
| N23                 | 288.71                       | 276.2                                 | 0.014                           | 0.550                                    | 0.051                              | 95%S+5%A   |
| RH=80%              |                              |                                       |                                 |  |                                    |  |
| N31                 | 279.708                      | 223.4                                 | 0.010                           | 0.320                                    | 0.097                              | 20%A+80%S  |
| N32                 | 284.493                      | 187                                   | 0.009                           | 1.385                                    | 0.154                              | 98%S+20%A  |
| N33                 | 275.726                      | 167.9                                 | 0.003                           | 1.119                                    | 0.124                              | 95%S+5%A   |
| RH=95%              |                              |                                       |                                 |  |                                    |  |
| N41                 | 285.319                      | 336.8                                 | 0.014                           | 0.282                                    | 0.052                              | 15%S+85%A  |
| N42                 | 276.686                      | 88.19                                 | 0.006                           | 0.315                                    | 0.045                              | 10%S+90%A  |
| N43                 | 290.384                      | 143.2                                 | 0.019                           | 0.975                                    | 0.109                              | 95%S+5%A   |
| With Primer Sika 55 |                              |                                       |                                 |  |                                    |  |
| RH=50%              |                              |                                       |                                 |  |                                    |  |
| N11P                | 280.312                      | 223                                   | 0.020                           | 0.594                                    | 0.077                              | 100%S  |
| N12P*               | 279.058                      | 297.7                                 | 0.010                           | 2.595                                    | 0.179                              | 100%S  |
| N13P*               | 275.824                      | 332.9                                 | 0.007                           | 3.087                                    | 0.213                              | 100%S  |
| RH=65%              |                              |                                       |                                 |  |                                    |  |
| N21P*               | 274.124                      | 235                                   | 0.011                           | 1.882                                    | 0.144                              | 100%S  |
| N22P                | 264.988                      | 113.4                                 | 0.013                           | 1.033                                    | 0.129                              | 95%S+5%A   |
| N23P                | 288.71                       | 187.4                                 | 0.009                           | 0.430                                    | 0.050                              | 10%S+90%A  |
| RH=80%              |                              |                                       |                                 |  |                                    |  |
| N31P                | 279.708                      | 91.11                                 | 0.008                           | 0.155                                    | 0.019                              | 10%S+90%A  |
| N32PX               | 284.493                      | 0                                     | 0.009                           | 0.461                                    | 0.080                              | 66%S+34%A  |
| N33P                | 275.726                      | 166.47                                | 0.008                           | 0.223                                    | 0.052                              | 20%S+80%A  |
| RH=95%              |                              |                                       |                                 |  |                                    |  |
| N41P                | 285.319                      | 144.1                                 | 0.015                           | 0.481                                    | 0.059                              | 90%S+10%A  |
| N42P                | 276.686                      | 134.9                                 | 0.004                           | 0.285                                    | 0.062                              | 50%S+50%A  |
| N43P                | 290.384                      | 156.3                                 | 0.008                           | 0.825                                    | 0.114                              | 40%S+60%A  |

Table 13B. Adhesive Sika 30 at Temperature 70°F.

| TEST                | Mass of<br>Mortar Cube<br>grams | Peak Load to<br>pull off dolly<br>pounds | Adhesive Film<br>Thickness<br>inch | Pulled off Mass<br>of Mortar Layer<br>grams | Max Height of<br>Mortar Layer<br>inch | Type of Failure<br>S=substrate<br>A=adhesive<br>C=cohesive |
|---------------------|---------------------------------|--|------------------------------------|---|---------------------------------------|--|
| Without Primer      |                                 |  |                                    |   |                                       |  |
| RH=50%              |                                 |  |                                    |   |                                       |  |
| N11                 | 280.312                         | 168.3                                    | 0.012                              | 0.573                                       | 0.058                                 | 100%S  |
| N12                 | 279.058                         | 321                                      | 0.008                              | 0.716                                       | 0.104                                 | 100%S  |
| N13*                | 275.824                         | 275.2                                    | 0.012                              | 2.639                                       | 0.199                                 | 100%S  |
| Average             |                                 | <b>254.83</b>                            | <b>0.011</b>                       | <b>1.309</b>                                | <b>0.120</b>                          |  |
| RH=65%              |                                 |  |                                    |   |                                       |  |
| N21                 | 274.124                         | 108.2                                    | 0.011                              | 0.618                                       | 0.149                                 | 100%S  |
| N22                 | 264.988                         | 280.9                                    | 0.005                              | 0.771                                       | 0.234                                 | 90%S+10%A  |
| N23                 | 288.71                          | 276.2                                    | 0.014                              | 0.550                                       | 0.051                                 | 95%S+5%A   |
| Average             |                                 | <b>221.77</b>                            | <b>0.010</b>                       | <b>0.646</b>                                | <b>0.145</b>                          |  |
| RH=80%              |                                 |  |                                    |   |                                       |  |
| N31                 | 279.708                         | 223.4                                    | 0.010                              | 0.320                                       | 0.097                                 | 20%A+80%S  |
| N32                 | 284.493                         | 187                                      | 0.009                              | 1.385                                       | 0.154                                 | 98%S+20%A  |
| N33                 | 275.726                         | 167.9                                    | 0.003                              | 1.119                                       | 0.124                                 | 95%S+5%A   |
| Average             |                                 | <b>192.77</b>                            | <b>0.007</b>                       | <b>0.941</b>                                | <b>0.125</b>                          |  |
| RH=95%              |                                 |  |                                    |   |                                       |  |
| N41                 | 285.319                         | 336.8                                    | 0.014                              | 0.282                                       | 0.052                                 | 15%S+85%A  |
| N42                 | 276.686                         | 88.19                                    | 0.006                              | 0.315                                       | 0.045                                 | 10%S+90%A  |
| N43                 | 290.384                         | 143.2                                    | 0.019                              | 0.975                                       | 0.109                                 | 95%S+5%A   |
| Average             |                                 | <b>189.40</b>                            | <b>0.013</b>                       | <b>0.524</b>                                | <b>0.069</b>                          |  |
| With Primer Sika 55 |                                 |  |                                    |   |                                       |  |
| RH=50%              |                                 |  |                                    |   |                                       |  |
| N11P                | 280.312                         | 223                                      | 0.020                              | 0.594                                       | 0.077                                 | 100%S  |
| N12P*               | 279.058                         | 297.7                                    | 0.010                              | 2.595                                       | 0.179                                 | 100%S  |
| N13P*               | 275.824                         | 332.9                                    | 0.007                              | 3.087                                       | 0.213                                 | 100%S  |
| Average             |                                 | <b>284.53</b>                            | <b>0.012</b>                       | <b>2.092</b>                                | <b>0.156</b>                          |  |
| RH=65%              |                                 |  |                                    |   |                                       |  |
| N21P*               | 274.124                         | 235                                      | 0.011                              | 1.882                                       | 0.144                                 | 100%S  |
| N22P                | 264.988                         | 113.4                                    | 0.013                              | 1.033                                       | 0.129                                 | 95%S+5%A   |
| N23P                | 288.71                          | 187.4                                    | 0.009                              | 0.430                                       | 0.050                                 | 10%S+90%A  |
| Average             |                                 | <b>178.6</b>                             | <b>0.011</b>                       | <b>1.115</b>                                | <b>0.108</b>                          |  |
| RH=80%              |                                 |  |                                    |   |                                       |  |
| N31P                | 279.708                         | 91.11                                    | 0.008                              | 0.155                                       | 0.019                                 | 10%S+90%A  |
| N32PX               | 284.493                         | 0  | 0.009                              | 0.461                                       | 0.080                                 | 66%S+34%A  |
| N33P                | 275.726                         | 166.47                                   | 0.008                              | 0.223                                       | 0.052                                 | 20%S+80%A  |
| Average             |                                 | <b>128.79</b>                            | <b>0.008</b>                       | <b>0.280</b>                                | <b>0.050</b>                          |  |
| RH=95%              |                                 |  |                                    |   |                                       |  |
| N41P                | 285.319                         | 144.1                                    | 0.015                              | 0.481                                       | 0.059                                 | 90%S+10%A  |
| N42P                | 276.686                         | 134.9                                    | 0.004                              | 0.285                                       | 0.062                                 | 50%S+50%A  |
| N43P                | 290.384                         | 156.3                                    | 0.008                              | 0.825                                       | 0.114                                 | 40%S+60%A  |
| Average             |                                 | <b>145.1</b>                             | <b>0.009</b>                       | <b>0.530</b>                                | <b>0.078</b>                          |  |

Table 13C. Adhesive Sika 30 at Temperature 70°F.

|     | Average<br>Peak Load to<br>pull off dolly<br>pounds | Average<br>Adhesive Film<br>Thickness<br>inch | Average<br>Pulled off Mass<br>of Mortar Layer<br>grams | Average<br>Max Height of<br>Mortar Layer<br>inch |
|-----|---|---|--|--|
| RH% | Without Primer                                      |   |  |  |
| 50  | 254.83  | 0.011   | 1.309  | 0.12   |
| 65  | 221.77  | 0.01  | 0.646  | 0.145  |
| 80  | 192.77  | 0.007   | 0.941  | 0.125  |
| 95  | 189.4   | 0.013   | 0.524  | 0.069  |
|     | With Primer Sika 55                                 |   |  |  |
| 50  | 284.53  | 0.012   | 2.092  | 0.156  |
| 65  | 178.6   | 0.011   | 1.115  | 0.108  |
| 80  | 128.79  | 0.008   | 0.28   | 0.05   |
| 95  | 145.1   | 0.009   | 0.53   | 0.078  |

Data rearranged for plotting.

| RH% | No Primer | With Primer |
|-----|-----------|-------------|
| 50  | 254.83    | 284.53      |
| 65  | 221.77    | 178.6       |
| 80  | 192.77    | 128.79      |
| 95  | 189.4     | 145.1       |



Table 14. Adhesive Sika 30 at Temperature 85°F.

| TEST   | Mass of Mortar Cube<br>grams | Peak Load to pull off dolly<br>pounds | Adhesive Film Thickness<br>inch | Pulled off Mass of Mortar Layer<br>grams | Max Height of Mortar Layer<br>inch | Type of Failure<br>S=substrate<br>A=adhesive |
|--------|------------------------------|---------------------------------------|---------------------------------|--|------------------------------------|--|
| RH=50% |                              |                                       |                                 |  |                                    |  |
|        |                              | Without Primer                        |                                 |  |                                    |  |
| N51X   | 280.141                      | 0                                     | 0.016                           | 0.866                                    | 0.118                              | 85%S+15%A                                    |
| N52    | 281.79                       | 161.1                                 | 0.010                           | 0.976                                    | 0.074                              | 80%S+20%A                                    |
| N53    | 276.78                       | 82.5                                  | 0.030                           | 0.978                                    | 0.059                              | 70%S+30%A                                    |
|        |                              | With Primer Sika 55                   |                                 |  |                                    |  |
| N51P   | 280.141                      | 130.4                                 | 0.035                           | 1.330                                    | 0.102                              | 98%S+2%A                                     |
| N52P   | 281.79                       | 91.6                                  | 0.012                           | 0.942                                    | 0.093                              | 75%S+25%A                                    |
| N53P   | 276.78                       | 181.6                                 | 0.019                           | 0.879                                    | 0.069                              | 80%S+20%A                                    |
| RH=65% |                              |                                       |                                 |  |                                    |  |
|        |                              | Without Primer                        |                                 |  |                                    |  |
| N61*   | 292.429                      | 237.6                                 | 0.007                           | 1.686                                    | 0.173                              | 100%S  |
| N62    | 288.232                      | 180.2                                 | 0.008                           | 1.135                                    | 0.126                              | 90%S+10%A                                    |
| N63    | 282.199                      | 280.9                                 | 0.016                           | 1.157                                    | 0.141                              | 100%S  |
|        |                              | With Primer Sika 55                   |                                 |  |                                    |  |
| N61P   | 292.429                      | 98.5                                  | 0.013                           | 0.220                                    | 0.055                              | 20%S+80%A                                    |
| N62P   | 288.232                      | 178.7                                 | 0.021                           | 0.881                                    | 0.114                              | 90%S+10%A                                    |
| N63P   | 282.199                      | 198.9                                 | 0.009                           | 0.287                                    | 0.141                              | 60%S+40%A                                    |
| RH=80% |                              |                                       |                                 |  |                                    |  |
|        |                              | Without Primer                        |                                 |  |                                    |  |
| N71    | 290.506                      | 297.9                                 | 0.026                           | 1.287                                    | 0.112                              | 100%S  |
| N72    | 289.865                      | 133.7                                 | 0.011                           | 0.535                                    | 0.097                              | 80%S+20%A                                    |
| N73    | 293.065                      | 180                                   | 0.005                           | 0.926                                    | 0.109                              | 98%S+2%A                                     |
|        |                              | With Primer Sika 55                   |                                 |  |                                    |  |
| N71P   | 290.506                      | 91.4                                  | 0.008                           | 0.245                                    | 0.056                              | 20%S+80%A                                    |
| N72P   | 289.865                      | 57.72                                 | 0.017                           | 0.420                                    | 0.069                              | 25%S+75%A                                    |
| N73P   | 293.065                      | 299.9                                 | 0.029                           | 0.814                                    | 0.097                              | 100%S  |
| RH=95% |                              |                                       |                                 |  |                                    |  |
|        |                              | Without Primer                        |                                 |  |                                    |  |
| N81    | 284.219                      | 116.9                                 | 0.020                           | 0.633                                    | 0.089                              | 90%S+10%A                                    |
| N82    | 285.349                      | 271.3                                 | 0.024                           | 0.585                                    | 0.050                              | 100%S  |
| N83    | 282.322                      | 167.300                               | 0.014                           | 1.202                                    | 0.144                              | 98%S+2%A                                     |
|        |                              | With Primer Sika 55                   |                                 |  |                                    |  |
| N81P   | 284.219                      | 101.2                                 | 0.015                           | 0.727                                    | 0.119                              | 90%S+10%A                                    |
| N82P   | 285.349                      | 301.7                                 | 0.018                           | 0.435                                    | 0.049                              | 100%S  |
| N83P   | 282.322                      | 287.4                                 | 0.013                           | 0.670                                    | 0.112                              | 90%S+10%A                                    |

Table 14A. Adhesive Sika 30 at Temperature 85°F.

| TEST                | Mass of Mortar Cube<br>grams | Peak Load to pull off dolly<br>pounds | Adhesive Film Thickness<br>inch | Pulled off Mass of Mortar Layer<br>grams | Max Height of Mortar Layer<br>inch | Type of Failure<br>S=substrate<br>A=adhesive |
|---------------------|------------------------------|---------------------------------------|---------------------------------|--|------------------------------------|--|
| Without Primer      |                              |                                       |                                 |  |                                    |  |
| RH=50%              |                              |                                       |                                 |  |                                    |  |
| N51X                | 280.141                      | 0                                     | 0.016                           | 0.866                                    | 0.118                              | 85%S+15%A                                    |
| N52                 | 281.79                       | 161.1                                 | 0.010                           | 0.976                                    | 0.074                              | 80%S+20%A                                    |
| N53                 | 276.78                       | 82.5                                  | 0.030                           | 0.978                                    | 0.059                              | 70%S+30%A                                    |
| RH=65%              |                              |                                       |                                 |  |                                    |  |
| N61*                | 292.429                      | 237.6                                 | 0.007                           | 1.686                                    | 0.173                              | 100%S  |
| N62                 | 288.232                      | 180.2                                 | 0.008                           | 1.135                                    | 0.126                              | 90%S+10%A                                    |
| N63                 | 282.199                      | 280.9                                 | 0.016                           | 1.157                                    | 0.141                              | 100%S  |
| RH=80%              |                              |                                       |                                 |  |                                    |  |
| N71                 | 290.506                      | 297.9                                 | 0.026                           | 1.287                                    | 0.112                              | 100%S  |
| N72                 | 289.865                      | 133.7                                 | 0.011                           | 0.535                                    | 0.097                              | 80%S+20%A                                    |
| N73                 | 293.065                      | 180                                   | 0.005                           | 0.926                                    | 0.109                              | 98%S+2%A                                     |
| RH=95%              |                              |                                       |                                 |  |                                    |  |
| N81                 | 284.219                      | 116.9                                 | 0.020                           | 0.633                                    | 0.089                              | 90%S+10%A                                    |
| N82                 | 285.349                      | 271.3                                 | 0.024                           | 0.585                                    | 0.050                              | 100%S  |
| N83                 | 282.322                      | 167.300                               | 0.014                           | 1.202                                    | 0.144                              | 98%S+2%A                                     |
| With Primer Sika 55 |                              |                                       |                                 |  |                                    |  |
| RH=50%              |                              |                                       |                                 |  |                                    |  |
| N51P                | 280.141                      | 130.4                                 | 0.035                           | 1.330                                    | 0.102                              | 98%S+2%A                                     |
| N52P                | 281.79                       | 91.6                                  | 0.012                           | 0.942                                    | 0.093                              | 75%S+25%A                                    |
| N53P                | 276.78                       | 181.6                                 | 0.019                           | 0.879                                    | 0.069                              | 80%S+20%A                                    |
| RH=65%              |                              |                                       |                                 |  |                                    |  |
| N61P                | 292.429                      | 98.5                                  | 0.013                           | 0.220                                    | 0.055                              | 20%S+80%A                                    |
| N62P                | 288.232                      | 178.7                                 | 0.021                           | 0.881                                    | 0.114                              | 90%S+10%A                                    |
| N63P                | 282.199                      | 198.9                                 | 0.009                           | 0.287                                    | 0.141                              | 60%S+40%A                                    |
| RH=80%              |                              |                                       |                                 |  |                                    |  |
| N71P                | 290.506                      | 91.4                                  | 0.008                           | 0.245                                    | 0.056                              | 20%S+80%A                                    |
| N72P                | 289.865                      | 57.72                                 | 0.017                           | 0.420                                    | 0.069                              | 25%S+75%A                                    |
| N73P                | 293.065                      | 299.9                                 | 0.029                           | 0.814                                    | 0.097                              | 100%S  |
| RH=95%              |                              |                                       |                                 |  |                                    |  |
| N81P                | 284.219                      | 101.2                                 | 0.015                           | 0.727                                    | 0.119                              | 90%S+10%A                                    |
| N82P                | 285.349                      | 301.7                                 | 0.018                           | 0.435                                    | 0.049                              | 100%S  |
| N83P                | 282.322                      | 287.4                                 | 0.013                           | 0.670                                    | 0.112                              | 90%S+10%A                                    |

Table 14B. Adhesive Sika 30 at Temperature 85°F.

| TEST                | Mass of Mortar Cube<br>grams | Peak Load to pull off dolly<br>pounds | Adhesive Film Thickness<br>inch | Pulled off Mass of Mortar Layer<br>grams | Max Height of Mortar Layer<br>inch | Type of Failure<br>S=substrate<br>A=adhesive |
|---------------------|------------------------------|---------------------------------------|---------------------------------|--|------------------------------------|--|
| Without Primer      |                              |                                       |                                 |  |                                    |  |
| RH=50%              |                              |                                       |                                 |  |                                    |  |
| N51X                | 280.141                      | 0                                     | 0.016                           | 0.866                                    | 0.118                              | 85%S+15%A                                    |
| N52                 | 281.79                       | 161.1                                 | 0.010                           | 0.976                                    | 0.074                              | 80%S+20%A                                    |
| N53                 | 276.78                       | 82.5                                  | 0.030                           | 0.978                                    | 0.059                              | 70%S+30%A                                    |
| Average             |                              | <b>121.8</b>                          | <b>0.019</b>                    | <b>0.94</b>                              | <b>0.084</b>                       |  |
| RH=65%              |                              |                                       |                                 |  |                                    |  |
| N61*                | 292.429                      | 237.6                                 | 0.007                           | 1.686                                    | 0.173                              | 100%S  |
| N62                 | 288.232                      | 180.2                                 | 0.008                           | 1.135                                    | 0.126                              | 90%S+10%A                                    |
| N63                 | 282.199                      | 280.9                                 | 0.016                           | 1.157                                    | 0.141                              | 100%S  |
| Average             |                              | <b>232.9</b>                          | <b>0.010</b>                    | <b>1.326</b>                             | <b>0.147</b>                       |  |
| RH=80%              |                              |                                       |                                 |  |                                    |  |
| N71                 | 290.506                      | 297.9                                 | 0.026                           | 1.287                                    | 0.112                              | 100%S  |
| N72                 | 289.865                      | 133.7                                 | 0.011                           | 0.535                                    | 0.097                              | 80%S+20%A                                    |
| N73                 | 293.065                      | 180                                   | 0.005                           | 0.926                                    | 0.109                              | 98%S+2%A                                     |
| Average             |                              | <b>203.867</b>                        | <b>0.014</b>                    | <b>0.916</b>                             | <b>0.106</b>                       |  |
| RH=95%              |                              |                                       |                                 |  |                                    |  |
| N81                 | 284.219                      | 116.9                                 | 0.020                           | 0.633                                    | 0.089                              | 90%S+10%A                                    |
| N82                 | 285.349                      | 271.3                                 | 0.024                           | 0.585                                    | 0.050                              | 100%S  |
| N83                 | 282.322                      | 167.300                               | 0.014                           | 1.202                                    | 0.144                              | 98%S+2%A                                     |
| Average             |                              | <b>185.167</b>                        | <b>0.019</b>                    | <b>0.807</b>                             | <b>0.094</b>                       |  |
| With Primer Sika 55 |                              |                                       |                                 |  |                                    |  |
| RH=50%              |                              |                                       |                                 |  |                                    |  |
| N51P                | 280.141                      | 130.4                                 | 0.035                           | 1.330                                    | 0.102                              | 98%S+2%A                                     |
| N52P                | 281.79                       | 91.6                                  | 0.012                           | 0.942                                    | 0.093                              | 75%S+25%A                                    |
| N53P                | 276.78                       | 181.6                                 | 0.019                           | 0.879                                    | 0.069                              | 80%S+20%A                                    |
| Average             |                              | <b>134.533</b>                        | <b>0.022</b>                    | <b>1.050</b>                             | <b>0.088</b>                       |  |
| RH=65%              |                              |                                       |                                 |  |                                    |  |
| N61P                | 292.429                      | 98.5                                  | 0.013                           | 0.220                                    | 0.055                              | 20%S+80%A                                    |
| N62P                | 288.232                      | 178.7                                 | 0.021                           | 0.881                                    | 0.114                              | 90%S+10%A                                    |
| N63P                | 282.199                      | 198.9                                 | 0.009                           | 0.287                                    | 0.141                              | 60%S+40%A                                    |
| Average             |                              | <b>158.7</b>                          | <b>0.014</b>                    | <b>0.463</b>                             | <b>0.103</b>                       |  |
| RH=80%              |                              |                                       |                                 |  |                                    |  |
| N71P                | 290.506                      | 91.4                                  | 0.008                           | 0.245                                    | 0.056                              | 20%S+80%A                                    |
| N72P                | 289.865                      | 57.72                                 | 0.017                           | 0.420                                    | 0.069                              | 25%S+75%A                                    |
| N73P                | 293.065                      | 299.9                                 | 0.029                           | 0.814                                    | 0.097                              | 100%S  |
| Average             |                              | <b>149.673</b>                        | <b>0.018</b>                    | <b>0.493</b>                             | <b>0.074</b>                       |  |
| RH=95%              |                              |                                       |                                 |  |                                    |  |
| N81P                | 284.219                      | 101.2                                 | 0.015                           | 0.727                                    | 0.119                              | 90%S+10%A                                    |
| N82P                | 285.349                      | 301.7                                 | 0.018                           | 0.435                                    | 0.049                              | 100%S  |
| N83P                | 282.322                      | 287.4                                 | 0.013                           | 0.670                                    | 0.112                              | 90%S+10%A                                    |
| Average             |                              | <b>230.1</b>                          | <b>0.015</b>                    | <b>0.611</b>                             | <b>0.093</b>                       |  |

Table 14C. Adhesive Sika 30 at Temperature 85°F.

| TEST | Peak Load to<br>pull off dolly<br>pounds | Adhesive Film<br>Thickness<br>inch | Pulled off Mass<br>of Mortar Layer<br>grams | Max Height of<br>Mortar Layer<br>inch |
|------|--|------------------------------------|---|---------------------------------------|
| RH%  | Without Primer                           |                                    |   |                                       |
| 50   | 121.8                                    | 0.019                              | 0.94  | 0.084                                 |
| 65   | 232.9                                    | 0.01                               | 1.326                                       | 0.147                                 |
| 80   | 203.867                                  | 0.014                              | 0.916                                       | 0.106                                 |
| 95   | 185.167                                  | 0.019                              | 0.807                                       | 0.094                                 |
|      | With Primer Sika55                       |                                    |   |                                       |
| 50   | 134.533                                  | 0.022                              | 1.05  | 0.088                                 |
| 65   | 158.7                                    | 0.014                              | 0.463                                       | 0.103                                 |
| 80   | 149.673                                  | 0.018                              | 0.493                                       | 0.074                                 |
| 95   | 230.1                                    | 0.015                              | 0.611                                       | 0.093                                 |

Data rearranged for plotting

| RH% | No Primer | With Primer |
|-----|-----------|-------------|
| 50  | 121.8     | 134.533     |
| 65  | 232.9     | 158.7       |
| 80  | 203.867   | 149.673     |
| 95  | 185.167   | 230.1       |

Table 15. Adhesive Sika 30 at Temperature 100°F.

| TEST   | Mass of Mortar Cube<br>grams | Peak Load to pull off dolly<br>pounds | Adhesive Film Thickness<br>inch | Pulled off Mass of Mortar Layer<br>grams | Max Height of Mortar Layer<br>inch | Type of Failure<br>S=substrate<br>A=adhesive<br>C=cohesive |
|--------|------------------------------|---------------------------------------|---------------------------------|--|------------------------------------|--|
| RH=50% |                              | Without Primer                        |                                 |  |                                    |  |
| N91    | 287.858                      | 147.2                                 | 0.008                           | 0.349                                    | 0.061                              | 60%S+40%A  |
| N92    | 289.315                      | 212.3                                 | 0.012                           | 0.618                                    | 0.060                              | 100%S  |
| N93    | 282.628                      | 134.5                                 | 0.012                           | 0.555                                    | 0.189                              | 80%S+20%A  |
|        |                              | With Primer Sika 55                   |                                 |  |                                    |  |
| N91P   | 287.858                      | 65.48                                 | 0.014                           | 0.302                                    | 0.057                              | 30%S+70%A  |
| N92P   | 289.315                      | 117.2                                 | 0.010                           | 0.700                                    | 0.076                              | 95%S+5%A   |
| N93P   | 282.628                      | 204.8                                 | 0.011                           | 0.530                                    | 0.055                              | 95%S+5%A   |
| RH=65% |                              | Without Primer                        |                                 |  |                                    |  |
| N101   | 307.138                      | 129.4                                 | 0.01                            | 0.395                                    | 0.055                              | 70%S+30%A  |
| N102   | 293.312                      | 164.1                                 | 0.012                           | 0.59                                     | 0.071                              | 95%S+5%A   |
| N103   | 304.477                      | 213.7                                 | 0.009                           | 1.163                                    | 0.122                              | 100%S  |
|        |                              | With Primer Sika 55                   |                                 |  |                                    |  |
| N101P  | 307.138                      | 102                                   | 0.015                           | 0.385                                    | 0.066                              | 70%S+30%A  |
| N102P  | 293.312                      | 93.93                                 | 0.012                           | 0.597                                    | 0.073                              | 90%S+10%A  |
| N103P  | 304.477                      | 311.8                                 | 0.011                           | 0.9                                      | 0.114                              | 95%S+5%A   |
| RH=80% |                              | Without Primer                        |                                 |  |                                    |  |
| N111   | 288.235                      | 269                                   | 0.018                           | 1.1                                      | 0.116                              | 100%S  |
| N112   | 288.365                      | 144.9                                 | 0.012                           | 0.435                                    | 0.073                              | 70%S+30%A  |
| N113   | 297.109                      | 113                                   | 0.018                           | 0.635                                    | 0.124                              | 60%S+40%A  |
|        |                              | With Primer Sika 55                   |                                 |  |                                    |  |
| N111P  | 288.235                      | 223.8                                 | 0.008                           | 0.733                                    | 0.091                              | 60%S+40%A  |
| N112P  | 288.365                      | 189.5                                 | 0.011                           | 0.25                                     | 0.043                              | 5%S+95%A   |
| N113P  | 297.109                      | 309                                   | 0.012                           | 0.625                                    | 0.074                              | 97%S+3%A   |
| RH=95% |                              | Without Primer                        |                                 |  |                                    |  |
| N121*  | 302.726                      | 176.5                                 | 0.02                            | 1.628                                    | 0.177                              | 100%S  |
| N122   | 300.294                      | 157.9                                 | 0.021                           | 0.268                                    | 0.067                              | 10%S+90%A  |
| N123X  | 305.358                      | 0                                     | 0.012                           | 0.02                                     | 0.013                              | 100%S  |
|        |                              | With Primer Sika 55                   |                                 |  |                                    |  |
| N121P  | 302.726                      | 220.4                                 | 0.028                           | 0.538                                    | 0.108                              | 90%S+10%A  |
| N122P  | 300.294                      | 250.1                                 | 0.016                           | 0.604                                    | 0.08                               | 98%S+2%A   |
| N123P  | 305.358                      | 279.9                                 | 0.016                           | 0.335                                    | 0.059                              | 70%S+30%A  |

Table 15A. Adhesive Sika 30 at Temperature 100°F.

| TEST                | Mass of<br>Mortar Cube<br>grams | Peak Load to<br>pull off dolly<br>pounds | Adhesive Film<br>Thickness<br>inch | Pulled off Mass<br>of Mortar Layer<br>grams | Max Height of<br>Mortar Layer<br>inch | Type of Failure<br>S=substrate<br>A=adhesive<br>C=cohesive |
|---------------------|---------------------------------|--|------------------------------------|---|---------------------------------------|--|
| Without Primer      |                                 |  |                                    |   |                                       |  |
| RH=50%              |                                 |  |                                    |   |                                       |  |
| N91                 | 287.858                         | 147.2                                    | 0.008                              | 0.349                                       | 0.061                                 | 60%S+40%A  |
| N92                 | 289.315                         | 212.3                                    | 0.012                              | 0.618                                       | 0.060                                 | 100%S  |
| N93                 | 282.628                         | 134.5                                    | 0.012                              | 0.555                                       | 0.189                                 | 80%S+20%A  |
| RH=65%              |                                 |  |                                    |   |                                       |  |
| N101                | 307.138                         | 129.4                                    | 0.01                               | 0.395                                       | 0.055                                 | 70%S+30%A  |
| N102                | 293.312                         | 164.1                                    | 0.012                              | 0.59  | 0.071                                 | 95%S+5%A   |
| N103                | 304.477                         | 213.7                                    | 0.009                              | 1.163                                       | 0.122                                 | 100%S  |
| RH=80%              |                                 |  |                                    |   |                                       |  |
| N111                | 288.235                         | 269                                      | 0.018                              | 1.1   | 0.116                                 | 100%S  |
| N112                | 288.365                         | 144.9                                    | 0.012                              | 0.435                                       | 0.073                                 | 70%S+30%A  |
| N113                | 297.109                         | 113                                      | 0.018                              | 0.635                                       | 0.124                                 | 60%S+40%A  |
| RH=95%              |                                 |  |                                    |   |                                       |  |
| N121*               | 302.726                         | 176.5                                    | 0.02                               | 1.628                                       | 0.177                                 | 100%S  |
| N122                | 300.294                         | 157.9                                    | 0.021                              | 0.268                                       | 0.067                                 | 10%S+90%A  |
| N123X               | 305.358                         | 0  | 0.012                              | 0.02  | 0.013                                 | 100%S  |
| With Primer Sika 55 |                                 |  |                                    |   |                                       |  |
| RH=50%              |                                 |  |                                    |   |                                       |  |
| N91P                | 287.858                         | 65.48                                    | 0.014                              | 0.302                                       | 0.057                                 | 30%S+70%A  |
| N92P                | 289.315                         | 117.2                                    | 0.010                              | 0.700                                       | 0.076                                 | 95%S+5%A   |
| N93P                | 282.628                         | 204.8                                    | 0.011                              | 0.530                                       | 0.055                                 | 95%S+5%A   |
| RH=65%              |                                 |  |                                    |   |                                       |  |
| N101P               | 307.138                         | 102                                      | 0.015                              | 0.385                                       | 0.066                                 | 70%S+30%A  |
| N102P               | 293.312                         | 93.93                                    | 0.012                              | 0.597                                       | 0.073                                 | 90%S+10%A  |
| N103P               | 304.477                         | 311.8                                    | 0.011                              | 0.9   | 0.114                                 | 95%S+5%A   |
| RH=80%              |                                 |  |                                    |   |                                       |  |
| N111P               | 288.235                         | 223.8                                    | 0.008                              | 0.733                                       | 0.091                                 | 60%S+40%A  |
| N112P               | 288.365                         | 189.5                                    | 0.011                              | 0.25  | 0.043                                 | 5%S+95%A   |
| N113P               | 297.109                         | 309                                      | 0.012                              | 0.625                                       | 0.074                                 | 97%S+3%A   |
| RH=95%              |                                 |  |                                    |   |                                       |  |
| N121P               | 302.726                         | 220.4                                    | 0.028                              | 0.538                                       | 0.108                                 | 90%S+10%A  |
| N122P               | 300.294                         | 250.1                                    | 0.016                              | 0.604                                       | 0.08                                  | 98%S+2%A   |
| N123P               | 305.358                         | 279.9                                    | 0.016                              | 0.335                                       | 0.059                                 | 70%S+30%A  |

Table 15B. Adhesive Sika 30 at Temperature 100°F.

| TEST                | Mass of Mortar Cube<br>grams | Peak Load to pull off dolly<br>pounds | Adhesive Film Thickness<br>inch | Pulled off Mass of Mortar Layer<br>grams | Max Height of Mortar Layer<br>inch | Type of Failure<br>S=substrate<br>A=adhesive<br>C=cohesive |
|---------------------|------------------------------|---------------------------------------|---------------------------------|--|------------------------------------|--|
| Without Primer      |                              |                                       |                                 |  |                                    |  |
| RH=50%              |                              |                                       |                                 |  |                                    |  |
| N91                 | 287.858                      | 147.2                                 | 0.008                           | 0.349                                    | 0.061                              | 60%S+40%A  |
| N92                 | 289.315                      | 212.3                                 | 0.012                           | 0.618                                    | 0.060                              | 100%S  |
| N93                 | 282.628                      | 134.5                                 | 0.012                           | 0.555                                    | 0.189                              | 80%S+20%A  |
| Average             |                              | <b>164.7</b>                          | <b>0.011</b>                    | <b>0.507</b>                             | <b>0.103</b>                       |  |
| RH=65%              |                              |                                       |                                 |  |                                    |  |
| N101                | 307.138                      | 129.4                                 | 0.01                            | 0.395                                    | 0.055                              | 70%S+30%A  |
| N102                | 293.312                      | 164.1                                 | 0.012                           | 0.59                                     | 0.071                              | 95%S+5%A   |
| N103                | 304.477                      | 213.7                                 | 0.009                           | 1.163                                    | 0.122                              | 100%S  |
| Average             |                              | <b>169.1</b>                          | <b>0.010</b>                    | <b>0.716</b>                             | <b>0.083</b>                       |  |
| RH=80%              |                              |                                       |                                 |  |                                    |  |
| N111                | 288.235                      | 269                                   | 0.018                           | 1.1                                      | 0.116                              | 100%S  |
| N112                | 288.365                      | 144.9                                 | 0.012                           | 0.435                                    | 0.073                              | 70%S+30%A  |
| N113                | 297.109                      | 113                                   | 0.018                           | 0.635                                    | 0.124                              | 60%S+40%A  |
| Average             |                              | <b>175.6</b>                          | <b>0.016</b>                    | <b>0.723</b>                             | <b>0.104</b>                       |  |
| RH=95%              |                              |                                       |                                 |  |                                    |  |
| N121*               | 302.726                      | 176.5                                 | 0.02                            | 1.628                                    | 0.177                              | 100%S  |
| N122                | 300.294                      | 157.9                                 | 0.021                           | 0.268                                    | 0.067                              | 10%S+90%A  |
| N123X               | 305.358                      | 0                                     | 0.012                           | 0.02                                     | 0.013                              | 100%S  |
| Average             |                              | <b>167.2</b>                          | <b>0.018</b>                    | <b>0.639</b>                             | <b>0.086</b>                       |  |
| With Primer Sika 55 |                              |                                       |                                 |  |                                    |  |
| RH=50%              |                              |                                       |                                 |  |                                    |  |
| N91P                | 287.858                      | 65.48                                 | 0.014                           | 0.302                                    | 0.057                              | 30%S+70%A  |
| N92P                | 289.315                      | 117.2                                 | 0.010                           | 0.700                                    | 0.076                              | 95%S+5%A   |
| N93P                | 282.628                      | 204.8                                 | 0.011                           | 0.530                                    | 0.055                              | 95%S+5%A   |
| Average             |                              | <b>129.16</b>                         | <b>0.012</b>                    | <b>0.511</b>                             | <b>0.063</b>                       |  |
| RH=65%              |                              |                                       |                                 |  |                                    |  |
| N101P               | 307.138                      | 102                                   | 0.015                           | 0.385                                    | 0.066                              | 70%S+30%A  |
| N102P               | 293.312                      | 93.93                                 | 0.012                           | 0.597                                    | 0.073                              | 90%S+10%A  |
| N103P               | 304.477                      | 311.8                                 | 0.011                           | 0.9                                      | 0.114                              | 95%S+5%A   |
| Average             |                              | <b>169.2</b>                          | <b>0.013</b>                    | <b>0.627</b>                             | <b>0.084</b>                       |  |
| RH=80%              |                              |                                       |                                 |  |                                    |  |
| N111P               | 288.235                      | 223.8                                 | 0.008                           | 0.733                                    | 0.091                              | 60%S+40%A  |
| N112P               | 288.365                      | 189.5                                 | 0.011                           | 0.25                                     | 0.043                              | 5%S+95%A   |
| N113P               | 297.109                      | 309                                   | 0.012                           | 0.625                                    | 0.074                              | 97%S+3%A   |
| Average             |                              | <b>240.8</b>                          | <b>0.010</b>                    | <b>0.536</b>                             | <b>0.069</b>                       |  |
| RH=95%              |                              |                                       |                                 |  |                                    |  |
| N121P               | 302.726                      | 220.4                                 | 0.028                           | 0.538                                    | 0.108                              | 90%S+10%A  |
| N122P               | 300.294                      | 250.1                                 | 0.016                           | 0.604                                    | 0.08                               | 98%S+2%A   |
| N123P               | 305.358                      | 279.9                                 | 0.016                           | 0.335                                    | 0.059                              | 70%S+30%A  |
| Average             |                              | <b>250.1</b>                          | <b>0.020</b>                    | <b>0.492</b>                             | <b>0.082</b>                       |  |

Table 15C. Adhesive Sika 30 at Temperature 100°F.

| TEST                | Peak Load to<br>pull off dolly<br>pounds | Adhesive Film<br>Thickness<br>inch | Pulled off Mass<br>of Mortar Layer<br>grams | Max Height of<br>Mortar Layer<br>inch |
|---------------------|--|------------------------------------|---|---------------------------------------|
| Without Primer      |  |                                    |   |                                       |
| RH%                 |  |                                    |   |                                       |
| 50                  | 164.7                                    | 0.011                              | 0.507                                       | 0.103                                 |
| 65                  | 169.1                                    | 0.010                              | 0.716                                       | 0.083                                 |
| 80                  | 175.6                                    | 0.016                              | 0.723                                       | 0.104                                 |
| 95                  | 167.2                                    | 0.018                              | 0.639                                       | 0.086                                 |
| With Primer Sika 55 |  |                                    |   |                                       |
| RH%                 |  |                                    |   |                                       |
| 50                  | 129.16                                   | 0.012                              | 0.511                                       | 0.063                                 |
| 65                  | 169.2                                    | 0.013                              | 0.627                                       | 0.084                                 |
| 80                  | 240.8                                    | 0.010                              | 0.536                                       | 0.069                                 |
| 95                  | 250.1                                    | 0.020                              | 0.492                                       | 0.082                                 |

Data rearranged for plotting

| RH% | No Primer | With Primer |
|-----|-----------|-------------|
| 50  | 164.7     | 129.16      |
| 65  | 169.1     | 169.2       |
| 80  | 175.6     | 240.8       |
| 95  | 167.2     | 250.1       |



Table 16. Adhesive Sika 32 at Temperature 70°F.

| TEST   | Mass of Mortar Cube<br>grams | Peak Load to pull off dolly<br>pounds | Adhesive Film Thickness<br>inch | Pulled off Mass of Mortar Layer<br>grams | Max Height of Mortar Layer<br>inch | Type of Failure<br>S=substrate<br>A=adhesive<br>C=cohesive |
|--------|------------------------------|---------------------------------------|---------------------------------|--|------------------------------------|--|
| RH=50% |                              | Without Primer                        |                                 |  |                                    |  |
| N14    | 270.399                      | 372.1                                 | 0.002                           | 1.008                                    | 0.084                              | 100%S  |
| N15    | 282.337                      | 278.1                                 | 0.002                           | 1.379                                    | 0.151                              | 100%S  |
| N16*   | 291.342                      | 452.6                                 | 0.004                           | 3.530                                    | 0.192                              | 100%S  |
|        |                              | With Primer                           |                                 |  |                                    |  |
| N14P*  | 270.399                      | 390.9                                 | 0.001                           | 2.727                                    | 0.194                              | 100%S  |
| N15P   | 282.337                      | 340.3                                 | 0.002                           | 0.532                                    | 0.06                               | 100%S  |
| N16P   | 291.342                      | 411.4                                 | 0.025                           | 1.651                                    | 0.139                              | 100%S  |
| RH=65% |                              | Without Primer                        |                                 |  |                                    |  |
| N24    | 287.947                      | 276.2                                 | 0.01                            | 0.638                                    | 0.1                                | 100%S  |
| N25    | 285.454                      | 403.1                                 | 0.003                           | 0.405                                    | 0.034                              | 100%S  |
| N26    | 286.765                      | 359.9                                 | 0.008                           | 0.636                                    | 0.044                              | 100%S  |
|        |                              | With Primer Sika 55                   |                                 |  |                                    |  |
| N24P   | 287.947                      | 301.5                                 | 0.008                           | 0.705                                    | 0.059                              | 100%S  |
| N25P   | 285.454                      | 293.6                                 | 0.008                           | 0.447                                    | 0.054                              | 95%S+5%A   |
| N26P*  | 286.765                      | 436                                   | 0.004                           | 1.814                                    | 0.165                              | 100%S  |
| RH=80% |                              | Without Primer                        |                                 |  |                                    |  |
| N34    | 286.264                      | 268.7                                 | 0.002                           | 1.121                                    | 0.105                              | 100%S  |
| N35    | 283.979                      | 287.4                                 | 0.01                            | 1.06                                     | 0.108                              | 100%S  |
| N36    | 285.642                      | 221.2                                 | 0.003                           | 1.409                                    | 0.13                               | 100%S  |
|        |                              | With Primer Sika 55                   |                                 |  |                                    |  |
| N34P   | 286.264                      | 280.9                                 | 0.006                           | 0.876                                    | 0.094                              | 100%S  |
| N35P   | 283.979                      | 268.3                                 | 0.004                           | 0.866                                    | 0.099                              | 100%S  |
| N36P   | 285.642                      | 390.6                                 | 0.003                           | 0.345                                    | 0.055                              | 100%S  |
| RH=95% |                              | Without Primer                        |                                 |  |                                    |  |
| N44    | 286.217                      | 355.8                                 | 0.004                           | 0.521                                    | 0.053                              | 100%S  |
| N45*   | 279.68                       | 242.5                                 | 0.002                           | 1.887                                    | 0.149                              | 100%S  |
| N46*   | 273.337                      | 200.7                                 | 0.003                           | 1.998                                    | 0.219                              | 100%S  |
|        |                              | With Primer Sika 55                   |                                 |  |                                    |  |
| N44P   | 286.217                      | 306.2                                 | 0.003                           | 1.082                                    | 0.122                              | 100%S  |
| N45P   | 279.68                       | 314.6                                 | 0.002                           | 0.846                                    | 0.094                              | 100%S  |
| N46P   | 273.337                      | 297.7                                 | 0.004                           | 1.405                                    | 0.178                              | 100%S  |

Table 16A. Adhesive Sika 32 at Temperature 70°F.

| TEST                | Mass of Mortar Cube<br>grams | Peak Load to pull off dolly<br>pounds | Adhesive Film Thickness<br>inch | Pulled off Mass of Mortar Layer<br>grams | Max Height of Mortar Layer<br>inch | Type of Failure<br>S=substrate<br>A=adhesive<br>C=cohesive |
|---------------------|------------------------------|---------------------------------------|---------------------------------|--|------------------------------------|--|
| Without Primer      |                              |                                       |                                 |  |                                    |  |
| RH=50%              |                              |                                       |                                 |  |                                    |  |
| N14                 | 270.399                      | 372.1                                 | 0.002                           | 1.008                                    | 0.084                              | 100%S  |
| N15                 | 282.337                      | 278.1                                 | 0.002                           | 1.379                                    | 0.151                              | 100%S  |
| N16*                | 291.342                      | 452.6                                 | 0.004                           | 3.530                                    | 0.192                              | 100%S  |
| RH=65%              |                              |                                       |                                 |  |                                    |  |
| N24                 | 287.947                      | 276.2                                 | 0.010                           | 0.638                                    | 0.100                              | 100%S  |
| N25                 | 285.454                      | 403.1                                 | 0.003                           | 0.405                                    | 0.034                              | 100%S  |
| N26                 | 286.765                      | 359.9                                 | 0.008                           | 0.636                                    | 0.044                              | 100%S  |
| RH=80%              |                              |                                       |                                 |  |                                    |  |
| N34                 | 286.264                      | 268.7                                 | 0.002                           | 1.121                                    | 0.105                              | 100%S  |
| N35                 | 283.979                      | 287.4                                 | 0.010                           | 1.060                                    | 0.108                              | 100%S  |
| N36                 | 285.642                      | 221.2                                 | 0.003                           | 1.409                                    | 0.130                              | 100%S  |
| RH=95%              |                              |                                       |                                 |  |                                    |  |
| N44                 | 286.217                      | 355.8                                 | 0.004                           | 0.521                                    | 0.053                              | 100%S  |
| N45*                | 279.68                       | 242.5                                 | 0.002                           | 1.887                                    | 0.149                              | 100%S  |
| N46*                | 273.337                      | 200.7                                 | 0.003                           | 1.998                                    | 0.219                              | 100%S  |
| With Primer Sika 55 |                              |                                       |                                 |  |                                    |  |
| RH=50%              |                              |                                       |                                 |  |                                    |  |
| N14P*               | 270.399                      | 390.9                                 | 0.001                           | 2.727                                    | 0.194                              | 100%S  |
| N15P                | 282.337                      | 340.3                                 | 0.002                           | 0.532                                    | 0.06                               | 100%S  |
| N16P                | 291.342                      | 411.4                                 | 0.025                           | 1.651                                    | 0.139                              | 100%S  |
| RH=65%              |                              |                                       |                                 |  |                                    |  |
| N24P                | 287.947                      | 301.5                                 | 0.008                           | 0.705                                    | 0.059                              | 100%S  |
| N25P                | 285.454                      | 293.6                                 | 0.008                           | 0.447                                    | 0.054                              | 95%S+5%A   |
| N26P*               | 286.765                      | 436                                   | 0.004                           | 1.814                                    | 0.165                              | 100%S  |
| RH=80%              |                              |                                       |                                 |  |                                    |  |
| N34P                | 286.264                      | 280.9                                 | 0.006                           | 0.876                                    | 0.094                              | 100%S  |
| N35P                | 283.979                      | 268.3                                 | 0.004                           | 0.866                                    | 0.099                              | 100%S  |
| N36P                | 285.642                      | 390.6                                 | 0.003                           | 0.345                                    | 0.055                              | 100%S  |
| RH=95%              |                              |                                       |                                 |  |                                    |  |
| N44P                | 286.217                      | 306.2                                 | 0.003                           | 1.082                                    | 0.122                              | 100%S  |
| N45P                | 279.68                       | 314.6                                 | 0.002                           | 0.846                                    | 0.094                              | 100%S  |
| N46P                | 273.337                      | 297.7                                 | 0.004                           | 1.405                                    | 0.178                              | 100%S  |

Table 16B. Adhesive Sika 32 at Temperature 70°F.

| TEST                | Mass of Mortar Cube grams | Peak Load to pull off dolly pounds | Adhesive Film Thickness inch | Pulled off Mass of Mortar Layer grams | Max Height of Mortar Layer inch | Type of Failure<br>S=substrate<br>A=adhesive<br>C=cohesive |
|---------------------|---------------------------|------------------------------------|------------------------------|---------------------------------------|---------------------------------|--|
| Without Primer      |                           |                                    |                              |                                       |                                 |  |
| RH=50%              |                           |                                    |                              |                                       |                                 |  |
| N14                 | 270.399                   | 372.1                              | 0.002                        | 1.008                                 | 0.084                           | 100%S  |
| N15                 | 282.337                   | 278.1                              | 0.002                        | 1.379                                 | 0.151                           | 100%S  |
| N16*                | 291.342                   | 452.6                              | 0.004                        | 3.530                                 | 0.192                           | 100%S  |
| Average             |                           | <b>367.6</b>                       | <b>0.003</b>                 | <b>1.972</b>                          | <b>0.142</b>                    |  |
| RH=65%              |                           |                                    |                              |                                       |                                 |  |
| N24                 | 287.947                   | 276.2                              | 0.010                        | 0.638                                 | 0.100                           | 100%S  |
| N25                 | 285.454                   | 403.1                              | 0.003                        | 0.405                                 | 0.034                           | 100%S  |
| N26                 | 286.765                   | 359.9                              | 0.008                        | 0.636                                 | 0.044                           | 100%S  |
| Average             |                           | <b>346.4</b>                       | <b>0.007</b>                 | <b>0.560</b>                          | <b>0.059</b>                    |  |
| RH=80%              |                           |                                    |                              |                                       |                                 |  |
| N34                 | 286.264                   | 268.7                              | 0.002                        | 1.121                                 | 0.105                           | 100%S  |
| N35                 | 283.979                   | 287.4                              | 0.010                        | 1.060                                 | 0.108                           | 100%S  |
| N36                 | 285.642                   | 221.2                              | 0.003                        | 1.409                                 | 0.130                           | 100%S  |
| Average             |                           | <b>259.1</b>                       | <b>0.005</b>                 | <b>1.197</b>                          | <b>0.114</b>                    |  |
| RH=95%              |                           |                                    |                              |                                       |                                 |  |
| N44                 | 286.217                   | 355.8                              | 0.004                        | 0.521                                 | 0.053                           | 100%S  |
| N45*                | 279.68                    | 242.5                              | 0.002                        | 1.887                                 | 0.149                           | 100%S  |
| N46*                | 273.337                   | 200.7                              | 0.003                        | 1.998                                 | 0.219                           | 100%S  |
| Average             |                           | <b>266.3</b>                       | <b>0.003</b>                 | <b>1.469</b>                          | <b>0.140</b>                    |  |
| With Primer Sika 55 |                           |                                    |                              |                                       |                                 |  |
| RH=50%              |                           |                                    |                              |                                       |                                 |  |
| N14P*               | 270.399                   | 390.9                              | 0.001                        | 2.727                                 | 0.194                           | 100%S  |
| N15P                | 282.337                   | 340.3                              | 0.002                        | 0.532                                 | 0.06                            | 100%S  |
| N16P                | 291.342                   | 411.4                              | 0.025                        | 1.651                                 | 0.139                           | 100%S  |
| Average             |                           | <b>380.9</b>                       | <b>0.009</b>                 | <b>1.637</b>                          | <b>0.131</b>                    |  |
| RH=65%              |                           |                                    |                              |                                       |                                 |  |
| N24P                | 287.947                   | 301.5                              | 0.008                        | 0.705                                 | 0.059                           | 100%S  |
| N25P                | 285.454                   | 293.6                              | 0.008                        | 0.447                                 | 0.054                           | 95%S+5%A   |
| N26P*               | 286.765                   | 436                                | 0.004                        | 1.814                                 | 0.165                           | 100%S  |
| Average             |                           | <b>343.7</b>                       | <b>0.007</b>                 | <b>0.989</b>                          | <b>0.093</b>                    |  |
| RH=80%              |                           |                                    |                              |                                       |                                 |  |
| N34P                | 286.264                   | 280.9                              | 0.006                        | 0.876                                 | 0.094                           | 100%S  |
| N35P                | 283.979                   | 268.3                              | 0.004                        | 0.866                                 | 0.099                           | 100%S  |
| N36P                | 285.642                   | 390.6                              | 0.003                        | 0.345                                 | 0.055                           | 100%S  |
| Average             |                           | <b>313.3</b>                       | <b>0.004</b>                 | <b>0.696</b>                          | <b>0.083</b>                    |  |
| RH=95%              |                           |                                    |                              |                                       |                                 |  |
| N44P                | 286.217                   | 306.2                              | 0.003                        | 1.082                                 | 0.122                           | 100%S  |
| N45P                | 279.68                    | 314.6                              | 0.002                        | 0.846                                 | 0.094                           | 100%S  |
| N46P                | 273.337                   | 297.7                              | 0.004                        | 1.405                                 | 0.178                           | 100%S  |
| Average             |                           | <b>306.2</b>                       | <b>0.003</b>                 | <b>1.111</b>                          | <b>0.131</b>                    |  |

Table 16C. Adhesive Sika 32 at Temperature 70°F.

| TEST                | Peak Load to<br>pull off dolly<br>pounds | Adhesive Film<br>Thickness<br>inch | Pulled off Mass<br>of Mortar Layer<br>grams | Max Height of<br>Mortar Layer<br>inch |
|---------------------|--|------------------------------------|---|---------------------------------------|
| Without Primer      |  |                                    |   |                                       |
| RH%                 |  |                                    |   |                                       |
| 50                  | 367.6                                    | 0.003                              | 1.972                                       | 0.142                                 |
| 65                  | 346.4                                    | 0.007                              | 0.56  | 0.059                                 |
| 80                  | 259.1                                    | 0.005                              | 1.197                                       | 0.114                                 |
| 95                  | 266.3                                    | 0.003                              | 1.469                                       | 0.14                                  |
| With Primer Sika 55 |  |                                    |   |                                       |
| RH%                 |  |                                    |   |                                       |
| 50                  | 380.9                                    | 0.009                              | 1.637                                       | 0.131                                 |
| 65                  | 343.7                                    | 0.007                              | 0.989                                       | 0.093                                 |
| 80                  | 313.3                                    | 0.004                              | 0.696                                       | 0.083                                 |
| 95                  | 306.2                                    | 0.003                              | 1.111                                       | 0.131                                 |

Data rearranged for plotting

| RH% | No Primer | With Primer |
|-----|-----------|-------------|
| 50  | 367.6     | 380.9       |
| 65  | 346.4     | 343.7       |
| 80  | 259.1     | 313.3       |
| 95  | 266.3     | 306.2       |

Table 17. Adhesive Sika 32 at Temperature 85°F.

| TEST   | Mass of Mortar Cube<br>grams | Peak Load to pull off dolly<br>pounds | Adhesive Film Thickness<br>inch | Pulled off Mass of Mortar Layer<br>grams | Max Height of Mortar Layer<br>inch | Type of Failure<br>S=substrate<br>A=adhesive<br>C=cohesive |
|--------|------------------------------|---------------------------------------|---------------------------------|--|------------------------------------|--|
| RH=50% |                              | Without Primer                        |                                 |  |                                    |  |
| N54    | 281.776                      | 332.8                                 | 0.013                           | 0.725                                    | 0.042                              | 100%S  |
| N55    | 279.558                      | 273.8                                 | 0.017                           | 0.837                                    | 0.064                              | 100%S  |
| N56    | 288.795                      | 317.7                                 | 0.003                           | 1.147                                    | 0.112                              | 100%S  |
|        |                              | With Primer Sika 55                   |                                 |  |                                    |  |
| N54P   | 281.776                      | 389                                   | 0.003                           | 0.913                                    | 0.079                              | 100%S  |
| N55P*  | 279.558                      | 252.8                                 | 0.005                           | 1.686                                    | 0.099                              | 100%S  |
| N56P*  | 288.795                      | 483.8                                 | 0.005                           | 1.677                                    | 0.124                              | 100%S  |
| RH=65% |                              | Without Primer                        |                                 |  |                                    |  |
| N64    | 291.673                      | 394.6                                 | 0.002                           | 1.032                                    | 0.114                              | 100%S  |
| N65    | 289.44                       | 232.8                                 | 0.003                           | 1.301                                    | 0.104                              | 100%S  |
| N66*   | 288.04                       | 281.3                                 | 0.004                           | 2.027                                    | 0.159                              | 100%S  |
|        |                              | With Primer Sika 55                   |                                 |  |                                    |  |
| N64P   | 291.673                      | 312.6                                 | 0.006                           | 0.907                                    | 0.083                              | 90%S+10%A  |
| N65P*  | 289.44                       | 303.2                                 | 0.009                           | 1.697                                    | 0.129                              | 98%S+2%A   |
| N66P   | 288.04                       | 319.9                                 | 0.004                           | 1.380                                    | 0.147                              | 100%S  |
| RH=80% |                              | Without Primer                        |                                 |  |                                    |  |
| N74    | 281.978                      | 409.5                                 | 0.005                           | 0.473                                    | 0.045                              | 100%S  |
| N75*   | 292.584                      | 340.1                                 | 0.007                           | 3.947                                    | 0.239                              | 100%S  |
| N76    | 286.958                      | 394.5                                 | 0.005                           | 0.451                                    | 0.046                              | 95%S+5%A   |
|        |                              | With Primer Sika 55                   |                                 |  |                                    |  |
| N74P   | 281.978                      | 405.1                                 | 0.006                           | 0.508                                    | 0.084                              | 90%S+10%A  |
| N75P*  | 292.584                      | 439.2                                 | 0.009                           | 2.135                                    | 0.171                              | 95%S+5%A   |
| N76P*  | 286.958                      | 373.7                                 | 0.005                           | 2.640                                    | 0.22                               | 100%S  |
| RH=95% |                              | Without Primer                        |                                 |  |                                    |  |
| N84    | 291.642                      | 330.1                                 | 0.007                           | 1.240                                    | 0.100                              | 100%S  |
| N85    | 294.17                       | 335.4                                 | 0.003                           | 1.395                                    | 0.089                              | 100%S  |
| N86    | 288.356                      | 326.3                                 | 0.003                           | 1.512                                    | 0.114                              | 100%S  |
|        |                              | With Primer Sika 55                   |                                 |  |                                    |  |
| N84P*  | 291.642                      | 318                                   | 0.003                           | 2.227                                    | 0.189                              | 100%S  |
| N85P*  | 294.17                       | 280.9                                 | 0.005                           | 1.514                                    | 0.114                              | 100%S  |
| N86P*  | 288.356                      | 270.6                                 | 0.003                           | 1.697                                    | 0.171                              | 100%S  |

Table 17A. Adhesive Sika 32 at Temperature 85°F.

| TEST                | Mass of Mortar Cube<br>grams | Peak Load to pull off dolly<br>pounds | Adhesive Film Thickness<br>inch | Pulled off Mass of Mortar Layer<br>grams | Max Height of Mortar Layer<br>inch | Type of Failure<br>S=substrate<br>A=adhesive<br>C=cohesive |
|---------------------|------------------------------|---------------------------------------|---------------------------------|--|------------------------------------|--|
| Without Primer      |                              |                                       |                                 |  |                                    |  |
| RH=50%              |                              |                                       |                                 |  |                                    |  |
| N54                 | 281.776                      | 332.8                                 | 0.013                           | 0.725                                    | 0.042                              | 100%S  |
| N55                 | 279.558                      | 273.8                                 | 0.017                           | 0.837                                    | 0.064                              | 100%S  |
| N56                 | 288.795                      | 317.7                                 | 0.003                           | 1.147                                    | 0.112                              | 100%S  |
| RH=65%              |                              |                                       |                                 |  |                                    |  |
| N64                 | 291.673                      | 394.6                                 | 0.002                           | 1.032                                    | 0.114                              | 100%S  |
| N65                 | 289.44                       | 232.8                                 | 0.003                           | 1.301                                    | 0.104                              | 100%S  |
| N66*                | 288.04                       | 281.3                                 | 0.004                           | 2.027                                    | 0.159                              | 100%S  |
| RH=80%              |                              |                                       |                                 |  |                                    |  |
| N74                 | 281.978                      | 409.5                                 | 0.005                           | 0.473                                    | 0.045                              | 100%S  |
| N75*                | 292.584                      | 340.1                                 | 0.007                           | 3.947                                    | 0.239                              | 100%S  |
| N76                 | 286.958                      | 394.5                                 | 0.005                           | 0.451                                    | 0.046                              | 95%S+5%A   |
| RH=95%              |                              |                                       |                                 |  |                                    |  |
| N84                 | 291.642                      | 330.1                                 | 0.007                           | 1.240                                    | 0.100                              | 100%S  |
| N85                 | 294.17                       | 335.4                                 | 0.003                           | 1.395                                    | 0.089                              | 100%S  |
| N86                 | 288.356                      | 326.3                                 | 0.003                           | 1.512                                    | 0.114                              | 100%S  |
| With Primer Sika 55 |                              |                                       |                                 |  |                                    |  |
| RH=50%              |                              |                                       |                                 |  |                                    |  |
| N84P*               | 291.642                      | 318                                   | 0.003                           | 2.227                                    | 0.189                              | 100%S  |
| N85P*               | 294.17                       | 280.9                                 | 0.005                           | 1.514                                    | 0.114                              | 100%S  |
| N86P*               | 288.356                      | 270.6                                 | 0.003                           | 1.697                                    | 0.171                              | 100%S  |
| RH=65%              |                              |                                       |                                 |  |                                    |  |
| N54P                | 281.776                      | 389                                   | 0.003                           | 0.913                                    | 0.079                              | 100%S  |
| N55P*               | 279.558                      | 252.8                                 | 0.005                           | 1.686                                    | 0.099                              | 100%S  |
| N56P*               | 288.795                      | 483.8                                 | 0.005                           | 1.677                                    | 0.124                              | 100%S  |
| RH=80%              |                              |                                       |                                 |  |                                    |  |
| N64P                | 291.673                      | 312.6                                 | 0.006                           | 0.907                                    | 0.083                              | 90%S+10%A  |
| N65P*               | 289.44                       | 303.2                                 | 0.009                           | 1.697                                    | 0.129                              | 98%S+2%A   |
| N66P                | 288.04                       | 319.9                                 | 0.004                           | 1.380                                    | 0.147                              | 100%S  |
| RH=95%              |                              |                                       |                                 |  |                                    |  |
| N74P                | 281.978                      | 405.1                                 | 0.006                           | 0.508                                    | 0.084                              | 90%S+10%A  |
| N75P*               | 292.584                      | 439.2                                 | 0.009                           | 2.135                                    | 0.171                              | 95%S+5%A   |
| N76P*               | 286.958                      | 373.7                                 | 0.005                           | 2.640                                    | 0.22                               | 100%S  |

Table 17B. Adhesive Sika 32 at Temperature 85°F.

| TEST                | Mass of Mortar Cube<br>grams | Peak Load to pull off dolly<br>pounds | Adhesive Film Thickness<br>inch | Pulled off Mass of Mortar Layer<br>grams | Max Height of Mortar Layer<br>inch | Type of Failure<br>S=substrate<br>A=adhesive<br>C=cohesive |
|---------------------|------------------------------|---------------------------------------|---------------------------------|--|------------------------------------|--|
| Without Primer      |                              |                                       |                                 |  |                                    |  |
| RH=50%              |                              |                                       |                                 |  |                                    |  |
| N54                 | 281.776                      | 332.8                                 | 0.013                           | 0.725                                    | 0.042                              | 100%S  |
| N55                 | 279.558                      | 273.8                                 | 0.017                           | 0.837                                    | 0.064                              | 100%S  |
| N56                 | 288.795                      | 317.7                                 | 0.003                           | 1.147                                    | 0.112                              | 100%S  |
| Average             |                              | <b>308.1</b>                          | <b>0.011</b>                    | <b>0.903</b>                             | <b>0.073</b>                       |  |
| RH=65%              |                              |                                       |                                 |  |                                    |  |
| N64                 | 291.673                      | 394.6                                 | 0.002                           | 1.032                                    | 0.114                              | 100%S  |
| N65                 | 289.44                       | 232.8                                 | 0.003                           | 1.301                                    | 0.104                              | 100%S  |
| N66*                | 288.04                       | 281.3                                 | 0.004                           | 2.027                                    | 0.159                              | 100%S  |
| Average             |                              | <b>302.9</b>                          | <b>0.003</b>                    | <b>1.453</b>                             | <b>0.126</b>                       |  |
| RH=80%              |                              |                                       |                                 |  |                                    |  |
| N74                 | 281.978                      | 409.5                                 | 0.005                           | 0.473                                    | 0.045                              | 100%S  |
| N75*                | 292.584                      | 340.1                                 | 0.007                           | 3.947                                    | 0.239                              | 100%S  |
| N76                 | 286.958                      | 394.5                                 | 0.005                           | 0.451                                    | 0.046                              | 95%S+5%A   |
| Average             |                              | <b>381.4</b>                          | <b>0.006</b>                    | <b>1.624</b>                             | <b>0.110</b>                       |  |
| RH=95%              |                              |                                       |                                 |  |                                    |  |
| N84                 | 291.642                      | 330.1                                 | 0.007                           | 1.240                                    | 0.100                              | 100%S  |
| N85                 | 294.17                       | 335.4                                 | 0.003                           | 1.395                                    | 0.089                              | 100%S  |
| N86                 | 288.356                      | 326.3                                 | 0.003                           | 1.512                                    | 0.114                              | 100%S  |
| Average             |                              | <b>330.6</b>                          | <b>0.004</b>                    | <b>1.382</b>                             | <b>0.101</b>                       |  |
| With Primer Sika 55 |                              |                                       |                                 |  |                                    |  |
| RH=50%              |                              |                                       |                                 |  |                                    |  |
| N84P*               | 291.642                      | 318                                   | 0.003                           | 2.227                                    | 0.189                              | 100%S  |
| N85P*               | 294.17                       | 280.9                                 | 0.005                           | 1.514                                    | 0.114                              | 100%S  |
| N86P*               | 288.356                      | 270.6                                 | 0.003                           | 1.697                                    | 0.171                              | 100%S  |
| Average             |                              | <b>289.8</b>                          | <b>0.004</b>                    | <b>1.813</b>                             | <b>0.158</b>                       |  |
| RH=65%              |                              |                                       |                                 |  |                                    |  |
| N54P                | 281.776                      | 389                                   | 0.003                           | 0.913                                    | 0.079                              | 100%S  |
| N55P*               | 279.558                      | 252.8                                 | 0.005                           | 1.686                                    | 0.099                              | 100%S  |
| N56P*               | 288.795                      | 483.8                                 | 0.005                           | 1.677                                    | 0.124                              | 100%S  |
| Average             |                              | <b>375.2</b>                          | <b>0.004</b>                    | <b>1.425</b>                             | <b>0.101</b>                       |  |
| RH=80%              |                              |                                       |                                 |  |                                    |  |
| N64P                | 291.673                      | 312.6                                 | 0.006                           | 0.907                                    | 0.083                              | 90%S+10%A  |
| N65P*               | 289.44                       | 303.2                                 | 0.009                           | 1.697                                    | 0.129                              | 98%S+2%A   |
| N66P                | 288.04                       | 319.9                                 | 0.004                           | 1.380                                    | 0.147                              | 100%S  |
| Average             |                              | <b>311.9</b>                          | <b>0.006</b>                    | <b>1.328</b>                             | <b>0.120</b>                       |  |
| RH=95%              |                              |                                       |                                 |  |                                    |  |
| N74P                | 281.978                      | 405.1                                 | 0.006                           | 0.508                                    | 0.084                              | 90%S+10%A  |
| N75P*               | 292.584                      | 439.2                                 | 0.009                           | 2.135                                    | 0.171                              | 95%S+5%A   |
| N76P*               | 286.958                      | 373.7                                 | 0.005                           | 2.640                                    | 0.220                              | 100%S  |
| Average             |                              | <b>406.0</b>                          | <b>0.007</b>                    | <b>1.761</b>                             | <b>0.158</b>                       |  |

Table 17C. Adhesive Sika 32 at Temperature 85°F.

| TEST                | Peak Load to<br>pull off dolly<br>pounds | Adhesive Film<br>Thickness<br>inch | Pulled off Mass<br>of Mortar Layer<br>grams | Max Height of<br>Mortar Layer<br>inch |
|---------------------|--|------------------------------------|---|---------------------------------------|
| Without Primer      |  |                                    |   |                                       |
| RH%                 |  |                                    |   |                                       |
| 50                  | 308.1                                    | 0.011                              | 0.903                                       | 0.073                                 |
| 65                  | 302.9                                    | 0.003                              | 1.453                                       | 0.126                                 |
| 80                  | 381.4                                    | 0.006                              | 1.624                                       | 0.110                                 |
| 95                  | 330.6                                    | 0.004                              | 1.382                                       | 0.101                                 |
| With Primer Sika 55 |  |                                    |   |                                       |
| RH%                 |  |                                    |   |                                       |
| 50                  | 289.8                                    | 0.004                              | 1.813                                       | 0.158                                 |
| 65                  | 375.2                                    | 0.004                              | 1.425                                       | 0.101                                 |
| 80                  | 311.9                                    | 0.006                              | 1.328                                       | 0.120                                 |
| 95                  | 406                                      | 0.007                              | 1.761                                       | 0.158                                 |

Data rearranged for plotting

| RH% | No Primer | With Primer |
|-----|-----------|-------------|
| 50  | 308.1     | 289.8       |
| 65  | 302.9     | 375.2       |
| 80  | 381.4     | 311.9       |
| 95  | 330.6     | 406         |



Table 18. Adhesive Sika 32 at Temperature 100°F.

| TEST                | Mass of Mortar Cube<br>grams | Peak Load to pull off dolly<br>pounds | Adhesive Film Thickness<br>inch | Pulled off Mass of Mortar Layer<br>grams | Max Height of Mortar Layer<br>inch | Type of Failure<br>S=substrate<br>A=adhesive<br>C=cohesive |
|---------------------|------------------------------|---------------------------------------|---------------------------------|--|------------------------------------|--|
| RH=50%              |                              |                                       |                                 |  |                                    |  |
| Without Primer      |                              |                                       |                                 |  |                                    |  |
| N94*                | 280.561                      | 322.5                                 | 0.004                           | 1.715                                    | 0.161                              | 100%S  |
| N95                 | 283.215                      | 300.9                                 | 0.002                           | 0.445                                    | 0.034                              | 100%S  |
| N96                 | 279.572                      | 302                                   | 0.004                           | 0.423                                    | 0.049                              | 100%S  |
| With Primer Sika 55 |                              |                                       |                                 |  |                                    |  |
| N94P                | 280.561                      | 341.6                                 | 0.005                           | 0.440                                    | 0.040                              | 100%S  |
| N95P*               | 283.215                      | 319.5                                 | 0.004                           | 2.075                                    | 0.214                              | 100%S  |
| N96P                | 279.572                      | 348.7                                 | 0.003                           | 0.489                                    | 0.066                              | 100%S  |
| RH=65%              |                              |                                       |                                 |  |                                    |  |
| Without Primer      |                              |                                       |                                 |  |                                    |  |
| N104                | 301.486                      | 403.9                                 | 0.003                           | 0.725                                    | 0.09                               | 100%S  |
| N105*               | 289.653                      | 276.9                                 | 0.004                           | 3.11                                     | 0.245                              | 100%S  |
| N106                | 298.328                      | 329.1                                 | 0.010                           | 0.982                                    | 0.114                              | 98%S+2%A   |
| With Primer Sika 55 |                              |                                       |                                 |  |                                    |  |
| N104P               | 301.486                      | 382                                   | 0.005                           | 0.732                                    | 0.085                              | 100%S  |
| N105P               | 289.653                      | 313.6                                 | 0.005                           | 0.750                                    | 0.081                              | 100%S  |
| N106P               | 298.328                      | 305.8                                 | 0.006                           | 0.565                                    | 0.054                              | 98%S+2%A   |
| RH=80%              |                              |                                       |                                 |  |                                    |  |
| Without Primer      |                              |                                       |                                 |  |                                    |  |
| N114                | 292.419                      | 315.2                                 | 0.006                           | 1.230                                    | 0.163                              | 100%S  |
| N115                | 297.12                       | 294.9                                 | 0.004                           | 0.250                                    | 0.034                              | 100%S(thin lyr)  |
| N116                | 305.989                      | 259.3                                 | 0.009                           | 0.252                                    | 0.018                              | 100%S(thin lyr)  |
| With Primer Sika 55 |                              |                                       |                                 |  |                                    |  |
| N114P               | 292.419                      | 288.2                                 | 0.008                           | 0.325                                    | 0.031                              | 50%S+50%A  |
| N115P               | 297.12                       | 331.5                                 | 0.008                           | 1.468                                    | 0.149                              | 100%S  |
| N116P               | 305.989                      | 445.9                                 | 0.006                           | 0.402                                    | 0.073                              | 100%S(thin lyr)  |
| RH=95%              |                              |                                       |                                 |  |                                    |  |
| Without Primer      |                              |                                       |                                 |  |                                    |  |
| N124 SL             | 307.822                      | 63.03                                 | 0.020                           | 0.091                                    | 0.018                              | 1%S+99%A   |
| N125 SL             | 289.64                       | 48.97                                 | 0.017                           | 0.04                                     | 0.012                              | 100%C  |
| N126                | 305.451                      | 122.7                                 | 0.003                           | 0.086                                    | 0.038                              | 5%S+95%A   |
| With Primer Sika 55 |                              |                                       |                                 |  |                                    |  |
| N124PX              | 307.822                      | 0                                     | 0.012                           | 0.100                                    | 0.020                              | 100%A  |
| N125P               | 289.64                       | 86.07                                 | 0.027                           | 0.141                                    | 0.045                              | 1%S+99%A   |
| N126P               | 305.451                      | 357.9                                 | 0.004                           | 0.35                                     | 0.065                              | 90%S+10%A  |

Table 18A. Adhesive Sika 32 at Temperature 100°F.

| TEST                | Mass of<br>Mortar Cube<br>grams | Peak Load to<br>pull off dolly<br>pounds | Adhesive Film<br>Thickness<br>inch | Pulled off Mass<br>of Mortar Layer<br>grams | Max Height of<br>Mortar Layer<br>inch | Type of Failure<br>S=substrate<br>A=adhesive<br>C=cohesive |
|---------------------|---------------------------------|--|------------------------------------|---|---------------------------------------|--|
| Without Primer      |                                 |  |                                    |   |                                       |  |
| RH=50%              |                                 |  |                                    |   |                                       |  |
| N94*                | 280.561                         | 322.5                                    | 0.004                              | 1.715                                       | 0.161                                 | 100%S  |
| N95                 | 283.215                         | 300.9                                    | 0.002                              | 0.445                                       | 0.034                                 | 100%S  |
| N96                 | 279.572                         | 302                                      | 0.004                              | 0.423                                       | 0.049                                 | 100%S  |
| RH=65%              |                                 |  |                                    |   |                                       |  |
| N104                | 301.486                         | 403.9                                    | 0.003                              | 0.725                                       | 0.09                                  | 100%S  |
| N105*               | 289.653                         | 276.9                                    | 0.004                              | 3.11  | 0.245                                 | 100%S  |
| N106                | 298.328                         | 329.1                                    | 0.010                              | 0.982                                       | 0.114                                 | 98%S+2%A   |
| RH=80%              |                                 |  |                                    |   |                                       |  |
| N114                | 292.419                         | 315.2                                    | 0.006                              | 1.230                                       | 0.163                                 | 100%S  |
| N115                | 297.12                          | 294.9                                    | 0.004                              | 0.250                                       | 0.034                                 | 100%S(thin lyr)  |
| N116                | 305.989                         | 259.3                                    | 0.009                              | 0.252                                       | 0.018                                 | 100%S(thin lyr)  |
| RH=95%              |                                 |  |                                    |   |                                       |  |
| N124 SL             | 307.822                         | 63.03                                    | 0.020                              | 0.091                                       | 0.018                                 | 1%S+99%A   |
| N125 SL             | 289.64                          | 48.97                                    | 0.017                              | 0.04  | 0.012                                 | 100%C  |
| N126                | 305.451                         | 122.7                                    | 0.003                              | 0.086                                       | 0.038                                 | 5%S+95%A   |
| With Primer Sika 55 |                                 |  |                                    |   |                                       |  |
| RH=50%              |                                 |  |                                    |   |                                       |  |
| N94P                | 280.561                         | 341.6                                    | 0.005                              | 0.440                                       | 0.040                                 | 100%S  |
| N95P*               | 283.215                         | 319.5                                    | 0.004                              | 2.075                                       | 0.214                                 | 100%S  |
| N96P                | 279.572                         | 348.7                                    | 0.003                              | 0.489                                       | 0.066                                 | 100%S  |
| RH=65%              |                                 |  |                                    |   |                                       |  |
| N104P               | 301.486                         | 382                                      | 0.005                              | 0.732                                       | 0.085                                 | 100%S  |
| N105P               | 289.653                         | 313.6                                    | 0.005                              | 0.750                                       | 0.081                                 | 100%S  |
| N106P               | 298.328                         | 305.8                                    | 0.006                              | 0.565                                       | 0.054                                 | 98%S+2%A   |
| RH=80%              |                                 |  |                                    |   |                                       |  |
| N114P               | 292.419                         | 288.2                                    | 0.008                              | 0.325                                       | 0.031                                 | 50%S+50%A  |
| N115P               | 297.12                          | 331.5                                    | 0.008                              | 1.468                                       | 0.149                                 | 100%S  |
| N116P               | 305.989                         | 445.9                                    | 0.006                              | 0.402                                       | 0.073                                 | 100%S(thin lyr)  |
| RH=95%              |                                 |  |                                    |   |                                       |  |
| N124PX              | 307.822                         | 0  | 0.012                              | 0.100                                       | 0.020                                 | 100%A  |
| N125P               | 289.64                          | 86.07                                    | 0.027                              | 0.141                                       | 0.045                                 | 1%S+99%A   |
| N126P               | 305.451                         | 357.9                                    | 0.004                              | 0.35  | 0.065                                 | 90%S+10%A  |

Table 18B. Adhesive Sika 32 at Temperature 100°F.

| TEST                | Mass of<br>Mortar Cube<br>grams | Peak Load to<br>pull off dolly<br>pounds | Adhesive Film<br>Thickness<br>inch | Pulled off Mass<br>of Mortar Layer<br>grams | Max Height of<br>Mortar Layer<br>inch | Type of Failure<br>S=substrate<br>A=adhesive<br>C=cohesive |
|---------------------|---------------------------------|--|------------------------------------|---|---------------------------------------|--|
| Without Primer      |                                 |  |                                    |   |                                       |  |
| RH=50%              |                                 |  |                                    |   |                                       |  |
| N94*                | 280.561                         | 322.5                                    | 0.004                              | 1.715                                       | 0.161                                 | 100%S  |
| N95                 | 283.215                         | 300.9                                    | 0.002                              | 0.445                                       | 0.034                                 | 100%S  |
| N96                 | 279.572                         | 302                                      | 0.004                              | 0.423                                       | 0.049                                 | 100%S  |
| Average             |                                 | <b>308.5</b>                             | <b>0.003</b>                       | <b>0.861</b>                                | <b>0.081</b>                          |  |
| RH=65%              |                                 |  |                                    |   |                                       |  |
| N104                | 301.486                         | 403.9                                    | 0.003                              | 0.725                                       | 0.09                                  | 100%S  |
| N105*               | 289.653                         | 276.9                                    | 0.004                              | 3.11  | 0.245                                 | 100%S  |
| N106                | 298.328                         | 329.1                                    | 0.010                              | 0.982                                       | 0.114                                 | 98%S+2%A   |
| Average             |                                 | <b>336.6</b>                             | <b>0.006</b>                       | <b>1.606</b>                                | <b>0.150</b>                          |  |
| RH=80%              |                                 |  |                                    |   |                                       |  |
| N114                | 292.419                         | 315.2                                    | 0.006                              | 1.230                                       | 0.163                                 | 100%S  |
| N115                | 297.12                          | 294.9                                    | 0.004                              | 0.250                                       | 0.034                                 | 100%S(thin lyr)  |
| N116                | 305.989                         | 259.3                                    | 0.009                              | 0.252                                       | 0.018                                 | 100%S(thin lyr)  |
| Average             |                                 | <b>289.8</b>                             | <b>0.006</b>                       | <b>0.577</b>                                | <b>0.072</b>                          |  |
| RH=95%              |                                 |  |                                    |   |                                       |  |
| N124 SL             | 307.822                         | 63.03X                                   | 0.020                              | 0.091                                       | 0.018                                 | 1%S+99%A   |
| N125 SL             | 289.64                          | 48.97X                                   | 0.017                              | 0.04  | 0.012                                 | 100%C  |
| N126                | 305.451                         | 122.7                                    | 0.003                              | 0.086                                       | 0.038                                 | 5%S+95%A   |
| Average             |                                 | <b>122.7</b>                             | <b>0.013</b>                       | <b>0.072</b>                                | <b>0.023</b>                          |  |
| With Primer Sika 55 |                                 |  |                                    |   |                                       |  |
| RH=50%              |                                 |  |                                    |   |                                       |  |
| N94P                | 280.561                         | 341.6                                    | 0.005                              | 0.440                                       | 0.040                                 | 100%S  |
| N95P*               | 283.215                         | 319.5                                    | 0.004                              | 2.075                                       | 0.214                                 | 100%S  |
| N96P                | 279.572                         | 348.7                                    | 0.003                              | 0.489                                       | 0.066                                 | 100%S  |
| Average             |                                 | <b>336.6</b>                             | <b>0.004</b>                       | <b>1.001</b>                                | <b>0.107</b>                          |  |
| RH=65%              |                                 |  |                                    |   |                                       |  |
| N104P               | 301.486                         | 382                                      | 0.005                              | 0.732                                       | 0.085                                 | 100%S  |
| N105P               | 289.653                         | 313.6                                    | 0.005                              | 0.750                                       | 0.081                                 | 100%S  |
| N106P               | 298.328                         | 305.8                                    | 0.006                              | 0.565                                       | 0.054                                 | 98%S+2%A   |
| Average             |                                 | <b>333.8</b>                             | <b>0.005</b>                       | <b>0.682</b>                                | <b>0.073</b>                          |  |
| RH=80%              |                                 |  |                                    |   |                                       |  |
| N114P               | 292.419                         | 288.2                                    | 0.008                              | 0.325                                       | 0.031                                 | 50%S+50%A  |
| N115P               | 297.12                          | 331.5                                    | 0.008                              | 1.468                                       | 0.149                                 | 100%S  |
| N116P               | 305.989                         | 445.9                                    | 0.006                              | 0.402                                       | 0.073                                 | 100%S(thin lyr)  |
| Average             |                                 | <b>355.2</b>                             | <b>0.007</b>                       | <b>0.732</b>                                | <b>0.084</b>                          |  |
| RH=95%              |                                 |  |                                    |   |                                       |  |
| N124PX              | 307.822                         | 0  | 0.012                              | 0.100                                       | 0.020                                 | 100%A  |
| N125P               | 289.64                          | 86.07                                    | 0.027                              | 0.141                                       | 0.045                                 | 1%S+99%A   |
| N126P               | 305.451                         | 357.9                                    | 0.004                              | 0.35  | 0.065                                 | 90%S+10%A  |
| Average             |                                 | <b>222.0</b>                             | <b>0.014</b>                       | <b>0.197</b>                                | <b>0.043</b>                          |  |

Table 18C. Adhesive Sika 32 at Temperature 100°F.

| TEST                | Peak Load to<br>pull off dolly<br>pounds | Adhesive Film<br>Thickness<br>inch | Pulled off Mass<br>of Mortar Layer<br>grams | Max Height of<br>Mortar Layer<br>inch |
|---------------------|--|------------------------------------|---|---------------------------------------|
| Without Primer      |  |                                    |   |                                       |
| RH%                 |  |                                    |   |                                       |
| 50                  | 308.5                                    | 0.003                              | 0.861                                       | 0.081                                 |
| 65                  | 336.6                                    | 0.006                              | 1.606                                       | 0.15                                  |
| 80                  | 289.8                                    | 0.006                              | 0.577                                       | 0.072                                 |
| 95                  | 122.7                                    | 0.013                              | 0.072                                       | 0.023                                 |
| With Primer Sika 55 |  |                                    |   |                                       |
| RH%                 |  |                                    |   |                                       |
| 50                  | 336.6                                    | 0.004                              | 1.001                                       | 0.107                                 |
| 65                  | 333.8                                    | 0.005                              | 0.682                                       | 0.073                                 |
| 80                  | 355.2                                    | 0.007                              | 0.732                                       | 0.084                                 |
| 95                  | 222                                      | 0.014                              | 0.197                                       | 0.043                                 |

Data rearranged for plotting

| RH% | No Primer | With Primer |
|-----|-----------|-------------|
| 50  | 308.5     | 336.6       |
| 65  | 336.6     | 333.8       |
| 80  | 289.8     | 355.2       |
| 95  | 122.7     | 222         |

Table 19. Adhesive Madewell 1312 at Temperature 70°F.

| TEST                     | Mass of<br>Mortar Cube<br>grams | Peak Load to<br>pull off dolly<br>pounds | Adhesive Film<br>Thickness<br>inch | Pulled off Mass<br>of Mortar Layer<br>grams | Max Height of<br>Mortar Layer<br>inch | Type of Failure<br>S=substrate<br>A=adhesive<br>C=cohesive |
|--------------------------|---------------------------------|--|------------------------------------|---|---------------------------------------|--|
| RH=50%                   |                                 |  |                                    |   |                                       |  |
| Without Primer           |                                 |  |                                    |   |                                       |  |
| N17                      | 281.962                         | 212.6                                    | 0.005                              | 0.609                                       | 0.104                                 | 100%S  |
| N18*                     | 291.696                         | 315.2                                    | 0.001                              | 1.746                                       | 0.159                                 | 100%S  |
| N19                      | 281.738                         | 243.2                                    | 0.005                              | 0.891                                       | 0.146                                 | 100%S  |
| With Primer Madewell 927 |                                 |  |                                    |   |                                       |  |
| N17P                     | 281.962                         | 244.2                                    | 0.001                              | 1.937                                       | 0.159                                 | 100%S  |
| N18P*                    | 291.696                         | 329.4                                    | 0.008                              | 2.097                                       | 0.183                                 | 100%S  |
| N19P                     | 281.738                         | 183.4                                    | 0.002                              | 0.982                                       | 0.119                                 | 100%S  |
| RH=65%                   |                                 |  |                                    |   |                                       |  |
| Without Primer           |                                 |  |                                    |   |                                       |  |
| N27-SL                   | 286.433                         | 149.4                                    | 0.005                              | 0.497                                       | 0.091                                 | 90%S+10%A  |
| N28                      | 265.607                         | 161.3                                    | 0.012                              | 1.011                                       | 0.164                                 | 100%S  |
| N29                      | 276.982                         | 267.2                                    | 0.006                              | 1.114                                       | 0.168                                 | 100%S  |
| With Primer Madewell 927 |                                 |  |                                    |   |                                       |  |
| N27P                     | 286.433                         | 306                                      | 0.006                              | 1.448                                       | 0.129                                 | 100%S  |
| N28P*                    | 265.607                         | 167.3                                    | 0.005                              | 1.85  | 0.161                                 | 100%S  |
| N29P*                    | 276.982                         | 233.6                                    | 0.007                              | 2.103                                       | 0.159                                 | 100%S  |
| RH=80%                   |                                 |  |                                    |   |                                       |  |
| Without Primer           |                                 |  |                                    |   |                                       |  |
| N37                      | 280.439                         | 184.3                                    | 0.005                              | 0.731                                       | 0.088                                 | 100%S  |
| N38                      | 288.469                         | 136                                      | 0.002                              | 0.374                                       | 0.064                                 | 98%S+2%A   |
| N39                      | 270.004                         | 128.5                                    | 0.002                              | 0.845                                       | 0.151                                 | 95%S+5%A   |
| With Primer Madewell 927 |                                 |  |                                    |   |                                       |  |
| N37P                     | 280.439                         | 261.2                                    | 0.004                              | 0.876                                       | 0.109                                 | 100%S  |
| N38P                     | 288.469                         | 298.5                                    | 0.004                              | 0.809                                       | 0.084                                 | 100%S  |
| N39P                     | 270.004                         | 194.2                                    | 0.004                              | 1.221                                       | 0.117                                 | 100%S  |
| RH=95%                   |                                 |  |                                    |   |                                       |  |
| Without Primer           |                                 |  |                                    |   |                                       |  |
| N47                      | 278.662                         | 200.7                                    | 0.009                              | 0.892                                       | 0.118                                 | 96%S+4%A   |
| N48                      | 289.921                         | 315.4                                    | 0.009                              | 0.838                                       | 0.089                                 | 100%S  |
| N49                      | 281.559                         | 229.8                                    | 0.005                              | 1.422                                       | 0.169                                 | 100%S  |
| With Primer Madewell 927 |                                 |  |                                    |   |                                       |  |
| N47P                     | 278.662                         | 304.2                                    | 0.005                              | 1.272                                       | 0.132                                 | 100%S  |
| N48P*                    | 289.921                         | 369                                      | 0.004                              | 1.924                                       | 0.139                                 | 100%S  |
| N49P                     | 281.559                         | 264.2                                    | 0.004                              | 1.189                                       | 0.096                                 | 100%S  |

Table 19A. Adhesive Madewell 1312 at Temperature 70°F.

| TEST                     | Mass of<br>Mortar Cube<br>grams | Peak Load to<br>pull off dolly<br>pounds | Adhesive Film<br>Thickness<br>inch | Pulled off Mass<br>of Mortar Layer<br>grams | Max Height of<br>Mortar Layer<br>inch | Type of Failure<br>S=substrate<br>A=adhesive<br>C=cohesive |
|--------------------------|---------------------------------|--|------------------------------------|---|---------------------------------------|--|
| Without Primer           |                                 |  |                                    |   |                                       |  |
| RH=50%                   |                                 |  |                                    |   |                                       |  |
| N17                      | 281.962                         | 212.6                                    | 0.005                              | 0.609                                       | 0.104                                 | 100%S  |
| N18*                     | 291.696                         | 315.2                                    | 0.001                              | 1.746                                       | 0.159                                 | 100%S  |
| N19                      | 281.738                         | 243.2                                    | 0.005                              | 0.891                                       | 0.146                                 | 100%S  |
| RH=65%                   |                                 |  |                                    |   |                                       |  |
| N27-SL                   | 286.433                         | 149.4                                    | 0.005                              | 0.497                                       | 0.091                                 | 90%S+10%A  |
| N28                      | 265.607                         | 161.3                                    | 0.012                              | 1.011                                       | 0.164                                 | 100%S  |
| N29                      | 276.982                         | 267.2                                    | 0.006                              | 1.114                                       | 0.168                                 | 100%S  |
| RH=80%                   |                                 |  |                                    |   |                                       |  |
| N37                      | 280.439                         | 184.3                                    | 0.005                              | 0.731                                       | 0.088                                 | 100%S  |
| N38                      | 288.469                         | 136                                      | 0.002                              | 0.374                                       | 0.064                                 | 98%S+2%A   |
| N39                      | 270.004                         | 128.5                                    | 0.002                              | 0.845                                       | 0.151                                 | 95%S+5%A   |
| RH=95%                   |                                 |  |                                    |   |                                       |  |
| N47                      | 278.662                         | 200.7                                    | 0.009                              | 0.892                                       | 0.118                                 | 96%S+4%A   |
| N48                      | 289.921                         | 315.4                                    | 0.009                              | 0.838                                       | 0.089                                 | 100%S  |
| N49                      | 281.559                         | 229.8                                    | 0.005                              | 1.422                                       | 0.169                                 | 100%S  |
| With Primer Madewell 927 |                                 |  |                                    |   |                                       |  |
| RH=50%                   |                                 |  |                                    |   |                                       |  |
| N17P                     | 281.962                         | 244.2                                    | 0.001                              | 1.937                                       | 0.159                                 | 100%S  |
| N18P*                    | 291.696                         | 329.4                                    | 0.008                              | 2.097                                       | 0.183                                 | 100%S  |
| N19P                     | 281.738                         | 183.4                                    | 0.002                              | 0.982                                       | 0.119                                 | 100%S  |
| RH=65%                   |                                 |  |                                    |   |                                       |  |
| N27P                     | 286.433                         | 306                                      | 0.006                              | 1.448                                       | 0.129                                 | 100%S  |
| N28P*                    | 265.607                         | 167.3                                    | 0.005                              | 1.85  | 0.161                                 | 100%S  |
| N29P*                    | 276.982                         | 233.6                                    | 0.007                              | 2.103                                       | 0.159                                 | 100%S  |
| RH=80%                   |                                 |  |                                    |   |                                       |  |
| N37P                     | 280.439                         | 261.2                                    | 0.004                              | 0.876                                       | 0.109                                 | 100%S  |
| N38P                     | 288.469                         | 298.5                                    | 0.004                              | 0.809                                       | 0.084                                 | 100%S  |
| N39P                     | 270.004                         | 194.2                                    | 0.004                              | 1.221                                       | 0.117                                 | 100%S  |
| RH=95%                   |                                 |  |                                    |   |                                       |  |
| N47P                     | 278.662                         | 304.2                                    | 0.005                              | 1.272                                       | 0.132                                 | 100%S  |
| N48P*                    | 289.921                         | 369                                      | 0.004                              | 1.924                                       | 0.139                                 | 100%S  |
| N49P                     | 281.559                         | 264.2                                    | 0.004                              | 1.189                                       | 0.096                                 | 100%S  |

Table 19B. Adhesive Madewell 1312 at Temperature 70°F.

| TEST                     | Mass of<br>Mortar Cube<br>grams | Peak Load to<br>pull off dolly<br>pounds | Adhesive Film<br>Thickness<br>inch | Pulled off Mass<br>of Mortar Layer<br>grams | Max Height of<br>Mortar Layer<br>inch | Type of Failure<br>S=substrate<br>A=adhesive<br>C=cohesive |
|--------------------------|---------------------------------|--|------------------------------------|---|---------------------------------------|--|
| Without Primer           |                                 |  |                                    |   |                                       |  |
| RH=50%                   |                                 |  |                                    |   |                                       |  |
| N17                      | 281.962                         | 212.6                                    | 0.005                              | 0.609                                       | 0.104                                 | 100%S  |
| N18*                     | 291.696                         | 315.2                                    | 0.001                              | 1.746                                       | 0.159                                 | 100%S  |
| N19                      | 281.738                         | 243.2                                    | 0.005                              | 0.891                                       | 0.146                                 | 100%S  |
| Average                  |                                 | <b>257.0</b>                             | <b>0.004</b>                       | <b>1.082</b>                                | <b>0.136</b>                          |  |
| RH=65%                   |                                 |  |                                    |   |                                       |  |
| N27-SL                   | 286.433                         | 149.4                                    | 0.005                              | 0.497                                       | 0.091                                 | 90%S+10%A  |
| N28                      | 265.607                         | 161.3                                    | 0.012                              | 1.011                                       | 0.164                                 | 100%S  |
| N29                      | 276.982                         | 267.2                                    | 0.006                              | 1.114                                       | 0.168                                 | 100%S  |
| Average                  |                                 | <b>192.6</b>                             | <b>0.008</b>                       | <b>0.874</b>                                | <b>0.141</b>                          |  |
| RH=80%                   |                                 |  |                                    |   |                                       |  |
| N37                      | 280.439                         | 184.3                                    | 0.005                              | 0.731                                       | 0.088                                 | 100%S  |
| N38                      | 288.469                         | 136                                      | 0.002                              | 0.374                                       | 0.064                                 | 98%S+2%A   |
| N39                      | 270.004                         | 128.5                                    | 0.002                              | 0.845                                       | 0.151                                 | 95%S+5%A   |
| Average                  |                                 | <b>149.6</b>                             | <b>0.003</b>                       | <b>0.650</b>                                | <b>0.101</b>                          |  |
| RH=95%                   |                                 |  |                                    |   |                                       |  |
| N47                      | 278.662                         | 200.7                                    | 0.009                              | 0.892                                       | 0.118                                 | 96%S+4%A   |
| N48                      | 289.921                         | 315.4                                    | 0.009                              | 0.838                                       | 0.089                                 | 100%S  |
| N49                      | 281.559                         | 229.8                                    | 0.005                              | 1.422                                       | 0.169                                 | 100%S  |
| Average                  |                                 | <b>248.6</b>                             | <b>0.008</b>                       | <b>1.051</b>                                | <b>0.125</b>                          |  |
| With Primer Madewell 927 |                                 |  |                                    |   |                                       |  |
| RH=50%                   |                                 |  |                                    |   |                                       |  |
| N17P                     | 281.962                         | 244.2                                    | 0.001                              | 1.937                                       | 0.159                                 | 100%S  |
| N18P*                    | 291.696                         | 329.4                                    | 0.008                              | 2.097                                       | 0.183                                 | 100%S  |
| N19P                     | 281.738                         | 183.4                                    | 0.002                              | 0.982                                       | 0.119                                 | 100%S  |
| Average                  |                                 | <b>252.3</b>                             | <b>0.004</b>                       | <b>1.672</b>                                | <b>0.154</b>                          |  |
| RH=65%                   |                                 |  |                                    |   |                                       |  |
| N27P                     | 286.433                         | 306                                      | 0.006                              | 1.448                                       | 0.129                                 | 100%S  |
| N28P*                    | 265.607                         | 167.3                                    | 0.005                              | 1.85  | 0.161                                 | 100%S  |
| N29P*                    | 276.982                         | 233.6                                    | 0.007                              | 2.103                                       | 0.159                                 | 100%S  |
| Average                  |                                 | <b>235.6</b>                             | <b>0.006</b>                       | <b>1.800</b>                                | <b>0.150</b>                          |  |
| RH=80%                   |                                 |  |                                    |   |                                       |  |
| N37P                     | 280.439                         | 261.2                                    | 0.004                              | 0.876                                       | 0.109                                 | 100%S  |
| N38P                     | 288.469                         | 298.5                                    | 0.004                              | 0.809                                       | 0.084                                 | 100%S  |
| N39P                     | 270.004                         | 194.2                                    | 0.004                              | 1.221                                       | 0.117                                 | 100%S  |
| Average                  |                                 | <b>251.3</b>                             | <b>0.004</b>                       | <b>0.969</b>                                | <b>0.103</b>                          |  |
| RH=95%                   |                                 |  |                                    |   |                                       |  |
| N47P                     | 278.662                         | 304.2                                    | 0.005                              | 1.272                                       | 0.132                                 | 100%S  |
| N48P*                    | 289.921                         | 369                                      | 0.004                              | 1.924                                       | 0.139                                 | 100%S  |
| N49P                     | 281.559                         | 264.2                                    | 0.004                              | 1.189                                       | 0.096                                 | 100%S  |
| Average                  |                                 | <b>312.5</b>                             | <b>0.004</b>                       | <b>1.462</b>                                | <b>0.122</b>                          |  |

Table 19C. Adhesive Madewell 1312 at Temperature 70°F.

| TEST                     | Peak Load to<br>pull off dolly<br>pounds | Adhesive Film<br>Thickness<br>inch | Pulled off Mass<br>of Mortar Layer<br>grams | Max Height of<br>Mortar Layer<br>inch |
|--------------------------|--|------------------------------------|---|---------------------------------------|
| Without Primer           |  |                                    |   |                                       |
| RH%                      |  |                                    |   |                                       |
| 50                       | 257                                      | 0.004                              | 1.082                                       | 0.136                                 |
| 65                       | 192.6                                    | 0.008                              | 0.874                                       | 0.141                                 |
| 80                       | 149.6                                    | 0.003                              | 0.65  | 0.101                                 |
| 95                       | 248.6                                    | 0.008                              | 1.051                                       | 0.125                                 |
| With Primer Madewell 927 |  |                                    |   |                                       |
| RH%                      |  |                                    |   |                                       |
| 50                       | 252.3                                    | 0.004                              | 1.672                                       | 0.154                                 |
| 65                       | 235.6                                    | 0.006                              | 1.8   | 0.15                                  |
| 80                       | 251.3                                    | 0.004                              | 0.969                                       | 0.103                                 |
| 95                       | 312.5                                    | 0.004                              | 1.462                                       | 0.122                                 |

Data rearranged for plotting

| RH% | No Primer | With Primer |
|-----|-----------|-------------|
| 50  | 257       | 252.3       |
| 65  | 192.6     | 235.6       |
| 80  | 149.6     | 251.3       |
| 95  | 248.6     | 312.5       |



Table 20. Adhesive Madewell 1312 at Temperature 85°F.

| TEST   | Mass of Mortar Cube<br>grams | Peak Load to pull off dolly<br>pounds | Adhesive Film Thickness<br>inch | Pulled off Mass of Mortar Layer<br>grams | Max Height of Mortar Layer<br>inch | Type of Failure<br>S=substrate<br>A=adhesive<br>C=cohesive |
|--------|------------------------------|---------------------------------------|---------------------------------|--|------------------------------------|--|
| RH=50% |                              | Without Primer                        |                                 |  |                                    |  |
| N57    | 287.163                      | 406.7                                 | 0.004                           | 0.561                                    | 0.062                              | 98%S+2%A   |
| N58    | 290.875                      | 291.5                                 | 0.005                           | 0.525                                    | 0.067                              | 100%S  |
| N59    | 288.471                      | 170                                   | 0.005                           | 0.396                                    | 0.043                              | 100%S  |
|        |                              | With Primer Madewell 927              |                                 |  |                                    |  |
| N57PX  | 287.163                      | 0                                     | 0.006                           | 0.085                                    | 0.090                              | 100%A  |
| N58P   | 290.875                      | 458.3                                 | 0.004                           | 0.633                                    | 0.075                              | 98%S+2%A   |
| N59P   | 288.471                      | 330.3                                 | 0.003                           | 1.270                                    | 0.123                              | 100%S  |
| RH=65% |                              | Without Primer                        |                                 |  |                                    |  |
| N67*   | 289.809                      | 277.9                                 | 0.011                           | 2.105                                    | 0.207                              | 100%S  |
| N68 SL | 286.662                      | 253.7                                 | 0.009                           | 0.411                                    | 0.061                              | 75%S+25%A  |
| N69    | 292.428                      | 223.2                                 | 0.004                           | 0.922                                    | 0.124                              | 100%S  |
|        |                              | With Primer Madewell 927              |                                 |  |                                    |  |
| N67P*  | 289.809                      | 256                                   | 0.002                           | 1.731                                    | 0.144                              | 100%S  |
| N68P   | 286.662                      | 259.1                                 | 0.008                           | 0.747                                    | 0.083                              | 100%S  |
| N69P   | 292.428                      | 329.1                                 | 0.007                           | 0.908                                    | 0.094                              | 100%S  |
| RH=80% |                              | Without Primer                        |                                 |  |                                    |  |
| N77    | 285.693                      | 381.5                                 | 0.005                           | 0.798                                    | 0.107                              | 100%S  |
| N78*   | 292.739                      | 320.8                                 | 0.003                           | 1.557                                    | 0.112                              | 100%S  |
| N79    | 283.421                      | 375.4                                 | 0.007                           | 0.67                                     | 0.094                              | 100%S  |
|        |                              | With Primer Madewell 927              |                                 |  |                                    |  |
| N77P   | 285.693                      | 438.3                                 | 0.008                           | 0.471                                    | 0.059                              | 100%S  |
| N78P   | 292.739                      | 258.3                                 | 0.003                           | 0.843                                    | 0.1                                | 100%S  |
| N79P   | 283.421                      | 393.6                                 | 0.003                           | 0.519                                    | 0.065                              | 100%S  |
| RH=95% |                              | Without Primer                        |                                 |  |                                    |  |
| N87 SL | 290.119                      | 231.5                                 | 0.005                           | 1.105                                    | 0.14                               | 100%S  |
| N88    | 292.453                      | 231.8                                 | 0.007                           | 0.815                                    | 0.104                              | 95%S+5%A   |
| N89 SL | 291.94                       | 307.4                                 | 0.003                           | 1.07                                     | 0.127                              | 100%S  |
|        |                              | With Primer Madewell 927              |                                 |  |                                    |  |
| N87P   | 290.119                      | 332.1                                 | 0.004                           | 1.41                                     | 0.126                              | 100%S  |
| N88P   | 292.453                      | 337.6                                 | 0.009                           | 1  | 0.114                              | 100%S  |
| N89P*  | 291.94                       | 370.6                                 | 0.004                           | 2.72                                     | 0.199                              | 100%S  |

Table 20A. Adhesive Madewell 1312 at Temperature 85°F.

| TEST                     | Mass of<br>Mortar Cube<br>grams | Peak Load to<br>pull off dolly<br>pounds | Adhesive Film<br>Thickness<br>inch | Pulled off Mass<br>of Mortar Layer<br>grams | Max Height of<br>Mortar Layer<br>inch | Type of Failure<br>S=substrate<br>A=adhesive<br>C=cohesive |
|--------------------------|---------------------------------|--|------------------------------------|---|---------------------------------------|--|
| Without Primer           |                                 |  |                                    |   |                                       |  |
| RH=50%                   |                                 |  |                                    |   |                                       |  |
| N57                      | 287.163                         | 406.7                                    | 0.004                              | 0.561                                       | 0.062                                 | 98%S+2%A   |
| N58                      | 290.875                         | 291.5                                    | 0.005                              | 0.525                                       | 0.067                                 | 100%S  |
| N59                      | 288.471                         | 170                                      | 0.005                              | 0.396                                       | 0.043                                 | 100%S  |
| RH=65%                   |                                 |  |                                    |   |                                       |  |
| N67*                     | 289.809                         | 277.9                                    | 0.011                              | 2.105                                       | 0.207                                 | 100%S  |
| N68 SL                   | 286.662                         | 253.7                                    | 0.009                              | 0.411                                       | 0.061                                 | 75%S+25%A  |
| N69                      | 292.428                         | 223.2                                    | 0.004                              | 0.922                                       | 0.124                                 | 100%S  |
| RH=80%                   |                                 |  |                                    |   |                                       |  |
| N77                      | 285.693                         | 381.5                                    | 0.005                              | 0.798                                       | 0.107                                 | 100%S  |
| N78*                     | 292.739                         | 320.8                                    | 0.003                              | 1.557                                       | 0.112                                 | 100%S  |
| N79                      | 283.421                         | 375.4                                    | 0.007                              | 0.670                                       | 0.094                                 | 100%S  |
| RH=95%                   |                                 |  |                                    |   |                                       |  |
| N87 SL                   | 290.119                         | 231.5                                    | 0.005                              | 1.105                                       | 0.140                                 | 100%S  |
| N88                      | 292.453                         | 231.8                                    | 0.007                              | 0.815                                       | 0.104                                 | 95%S+5%A   |
| N89 SL                   | 291.94                          | 307.4                                    | 0.003                              | 1.070                                       | 0.127                                 | 100%S  |
| With Primer Madewell 927 |                                 |  |                                    |   |                                       |  |
| RH=50%                   |                                 |  |                                    |   |                                       |  |
| N87P                     | 290.119                         | 332.1                                    | 0.004                              | 1.410                                       | 0.126                                 | 100%S  |
| N88P                     | 292.453                         | 337.6                                    | 0.009                              | 1.000                                       | 0.114                                 | 100%S  |
| N89P*                    | 291.94                          | 370.6                                    | 0.004                              | 2.720                                       | 0.199                                 | 100%S  |
| RH=65%                   |                                 |  |                                    |   |                                       |  |
| N57PX                    | 287.163                         | 0  | 0.006                              | 0.085                                       | 0.090                                 | 100%A  |
| N58P                     | 290.875                         | 458.3                                    | 0.004                              | 0.633                                       | 0.075                                 | 98%S+2%A   |
| N59P                     | 288.471                         | 330.3                                    | 0.003                              | 1.270                                       | 0.123                                 | 100%S  |
| RH=80%                   |                                 |  |                                    |   |                                       |  |
| N67P*                    | 289.809                         | 256                                      | 0.002                              | 1.731                                       | 0.144                                 | 100%S  |
| N68P                     | 286.662                         | 259.1                                    | 0.008                              | 0.747                                       | 0.083                                 | 100%S  |
| N69P                     | 292.428                         | 329.1                                    | 0.007                              | 0.908                                       | 0.094                                 | 100%S  |
| RH=95%                   |                                 |  |                                    |   |                                       |  |
| N77P                     | 285.693                         | 438.3                                    | 0.008                              | 0.471                                       | 0.059                                 | 100%S  |
| N78P                     | 292.739                         | 258.3                                    | 0.003                              | 0.843                                       | 0.100                                 | 100%S  |
| N79P                     | 283.421                         | 393.6                                    | 0.003                              | 0.519                                       | 0.065                                 | 100%S  |

Table 20B. Adhesive Madewell 1312 at Temperature 85°F.

| TEST                     | Mass of<br>Mortar Cube<br>grams | Peak Load to<br>pull off dolly<br>pounds | Adhesive Film<br>Thickness<br>inch | Pulled off Mass<br>of Mortar Layer<br>grams | Max Height of<br>Mortar Layer<br>inch | Type of Failure<br>S=substrate<br>A=adhesive<br>C=cohesive |
|--------------------------|---------------------------------|--|------------------------------------|---|---------------------------------------|--|
| Without Primer           |                                 |  |                                    |   |                                       |  |
| RH=50%                   |                                 |  |                                    |   |                                       |  |
| N57                      | 287.163                         | 406.7                                    | 0.004                              | 0.561                                       | 0.062                                 | 98%S+2%A   |
| N58                      | 290.875                         | 291.5                                    | 0.005                              | 0.525                                       | 0.067                                 | 100%S  |
| N59                      | 288.471                         | 170                                      | 0.005                              | 0.396                                       | 0.043                                 | 100%S  |
| Average                  |                                 | <b>289.4</b>                             | <b>0.005</b>                       | <b>0.494</b>                                | <b>0.057</b>                          |  |
| RH=65%                   |                                 |  |                                    |   |                                       |  |
| N67*                     | 289.809                         | 277.9                                    | 0.011                              | 2.105                                       | 0.207                                 | 100%S  |
| N68 SL                   | 286.662                         | 253.7                                    | 0.009                              | 0.411                                       | 0.061                                 | 75%S+25%A  |
| N69                      | 292.428                         | 223.2                                    | 0.004                              | 0.922                                       | 0.124                                 | 100%S  |
| Average                  |                                 | <b>251.6</b>                             | <b>0.008</b>                       | <b>1.146</b>                                | <b>0.131</b>                          |  |
| RH=80%                   |                                 |  |                                    |   |                                       |  |
| N77                      | 285.693                         | 381.5                                    | 0.005                              | 0.798                                       | 0.107                                 | 100%S  |
| N78*                     | 292.739                         | 320.8                                    | 0.003                              | 1.557                                       | 0.112                                 | 100%S  |
| N79                      | 283.421                         | 375.4                                    | 0.007                              | 0.670                                       | 0.094                                 | 100%S  |
| Average                  |                                 | <b>359.2</b>                             | <b>0.005</b>                       | <b>1.008</b>                                | <b>0.104</b>                          |  |
| RH=95%                   |                                 |  |                                    |   |                                       |  |
| N87 SL                   | 290.119                         | 231.5                                    | 0.005                              | 1.105                                       | 0.140                                 | 100%S  |
| N88                      | 292.453                         | 231.8                                    | 0.007                              | 0.815                                       | 0.104                                 | 95%S+5%A   |
| N89 SL                   | 291.94                          | 307.4                                    | 0.003                              | 1.070                                       | 0.127                                 | 100%S  |
| Average                  |                                 | <b>256.9</b>                             | <b>0.005</b>                       | <b>0.997</b>                                | <b>0.124</b>                          |  |
| With Primer Madewell 927 |                                 |  |                                    |   |                                       |  |
| RH=50%                   |                                 |  |                                    |   |                                       |  |
| N87P                     | 290.119                         | 332.1                                    | 0.004                              | 1.410                                       | 0.126                                 | 100%S  |
| N88P                     | 292.453                         | 337.6                                    | 0.009                              | 1.000                                       | 0.114                                 | 100%S  |
| N89P*                    | 291.94                          | 370.6                                    | 0.004                              | 2.720                                       | 0.199                                 | 100%S  |
| Average                  |                                 | <b>346.8</b>                             | <b>0.006</b>                       | <b>1.710</b>                                | <b>0.146</b>                          |  |
| RH=65%                   |                                 |  |                                    |   |                                       |  |
| N57PX                    | 287.163                         | 0  | 0.006                              | 0.085                                       | 0.090                                 | 100%A  |
| N58P                     | 290.875                         | 458.3                                    | 0.004                              | 0.633                                       | 0.075                                 | 98%S+2%A   |
| N59P                     | 288.471                         | 330.3                                    | 0.003                              | 1.270                                       | 0.123                                 | 100%S  |
| Average                  |                                 | <b>394.3</b>                             | <b>0.004</b>                       | <b>0.663</b>                                | <b>0.096</b>                          |  |
| RH=80%                   |                                 |  |                                    |   |                                       |  |
| N67P*                    | 289.809                         | 256                                      | 0.002                              | 1.731                                       | 0.144                                 | 100%S  |
| N68P                     | 286.662                         | 259.1                                    | 0.008                              | 0.747                                       | 0.083                                 | 100%S  |
| N69P                     | 292.428                         | 329.1                                    | 0.007                              | 0.908                                       | 0.094                                 | 100%S  |
| Average                  |                                 | <b>281.4</b>                             | <b>0.006</b>                       | <b>1.129</b>                                | <b>0.107</b>                          |  |
| RH=95%                   |                                 |  |                                    |   |                                       |  |
| N77P                     | 285.693                         | 438.3                                    | 0.008                              | 0.471                                       | 0.059                                 | 100%S  |
| N78P                     | 292.739                         | 258.3                                    | 0.003                              | 0.843                                       | 0.100                                 | 100%S  |
| N79P                     | 283.421                         | 393.6                                    | 0.003                              | 0.519                                       | 0.065                                 | 100%S  |
| Average                  |                                 | <b>363.4</b>                             | <b>0.005</b>                       | <b>0.611</b>                                | <b>0.075</b>                          |  |

Table 20C. Adhesive Madewell 1312 at Temperature 85°F.

| TEST                     | Peak Load to<br>pull off dolly<br>pounds | Adhesive Film<br>Thickness<br>inch | Pulled off Mass<br>of Mortar Layer<br>grams | Max Height of<br>Mortar Layer<br>inch |
|--------------------------|--|------------------------------------|---|---------------------------------------|
| Without Primer           |  |                                    |   |                                       |
| RH%                      |  |                                    |   |                                       |
| 50                       | 289.4                                    | 0.005                              | 0.494                                       | 0.057                                 |
| 65                       | 251.6                                    | 0.008                              | 1.146                                       | 0.131                                 |
| 80                       | 359.2                                    | 0.005                              | 1.008                                       | 0.104                                 |
| 95                       | 256.9                                    | 0.005                              | 0.997                                       | 0.124                                 |
| With Primer Madewell 927 |  |                                    |   |                                       |
| RH%                      |  |                                    |   |                                       |
| 50                       | 346.8                                    | 0.006                              | 1.71  | 0.146                                 |
| 65                       | 394.3                                    | 0.004                              | 0.663                                       | 0.096                                 |
| 80                       | 281.4                                    | 0.006                              | 1.129                                       | 0.107                                 |
| 95                       | 363.4                                    | 0.005                              | 0.611                                       | 0.075                                 |

Data rearranged for plotting

| RH% | No Primer | With Primer |
|-----|-----------|-------------|
| 50  | 289.4     | 346.8       |
| 65  | 251.6     | 394.3       |
| 80  | 359.2     | 281.4       |
| 95  | 256.9     | 363.4       |

Table 21. Adhesive Madewell 1312 at Temperature 100°F.

| TEST                     | Mass of<br>Mortar Cube<br>grams | Peak Load to<br>pull off dolly<br>pounds | Adhesive Film<br>Thickness<br>inch | Pulled off Mass<br>of Mortar Layer<br>grams | Max Height of<br>Mortar Layer<br>inch | Type of Failure<br>S=substrate<br>A=adhesive<br>C=cohesive |
|--------------------------|---------------------------------|--|------------------------------------|---|---------------------------------------|--|
| RH=50%                   |                                 |  |                                    |   |                                       |  |
| Without Primer           |                                 |  |                                    |   |                                       |  |
| N97R                     | 280.561                         | 352.000                                  | 0.005                              | 0.497                                       | 0.070                                 | 98%S+2%A   |
| N98R                     | 283.215                         | 277.000                                  | 0.004                              | 0.509                                       | 0.085                                 | 100%S  |
| N99R                     | 279.572                         | 453.000                                  | 0.002                              | 0.468                                       | 0.060                                 | 100%S  |
| With Primer Madewell 927 |                                 |  |                                    |   |                                       |  |
| N97PR                    | 286.211                         | 428.200                                  | 0.003                              | 0.969                                       | 0.135                                 | 100%S  |
| N98PR                    | 281.546                         | 468.000                                  | 0.009                              | 0.642                                       | 0.095                                 | 100%S  |
| N99PR                    | 290.306                         | 412.800                                  | 0.003                              | 0.236                                       | 0.057                                 | 98%S+2%A   |
| RH=65%                   |                                 |  |                                    |   |                                       |  |
| Without Primer           |                                 |  |                                    |   |                                       |  |
| N107                     | 287.55                          | 243.8                                    | 0.003                              | 0.330                                       | 0.069                                 | 95%S+5%A   |
| N108*                    | 285.745                         | 320.4                                    | 0.004                              | 1.565                                       | 0.168                                 | 100%S  |
| N109                     | 287.488                         | 342.7                                    | 0.003                              | 0.552                                       | 0.072                                 | 100%S  |
| With Primer Madewell 927 |                                 |  |                                    |   |                                       |  |
| N107P                    | 287.55                          | 292.2                                    | 0.03                               | 0.530                                       | 0.067                                 | 95%S+5%A   |
| N108P                    | 285.745                         | 312.5                                    | 0.002                              | 0.270                                       | 0.090                                 | 40%S+60%A  |
| N109P                    | 287.488                         | 327.9                                    | 0.004                              | 0.619                                       | 0.075                                 | 100%S  |
| RH=80%                   |                                 |  |                                    |   |                                       |  |
| Without Primer           |                                 |  |                                    |   |                                       |  |
| N117                     | 306.328                         | 429.4                                    | 0.004                              | 0.345                                       | 0.087                                 | 75%S+25%A  |
| N118 SL                  | 309.997                         | 265.1                                    | 0.005                              | 0.785                                       | 0.126                                 | 100%S  |
| N119 SL                  | 287.058                         | 194.5                                    | 0.003                              | 0.955                                       | 0.124                                 | 100%S  |
| With Primer Madewell 927 |                                 |  |                                    |   |                                       |  |
| N117P                    | 306.328                         | 287.1                                    | 0.007                              | 1.117                                       | 0.133                                 | 100%S  |
| N118P                    | 309.997                         | 371.9                                    | 0.008                              | 0.255                                       | 0.030                                 | 100%S(thin lyr)  |
| N119P                    | 287.058                         | 350.3                                    | 0.003                              | 0.630                                       | 0.074                                 | 98%S+2%A   |
| Rh=95%                   |                                 |  |                                    |   |                                       |  |
| Without Primer           |                                 |  |                                    |   |                                       |  |
| N127X                    | 290.985                         | 0  | 0.003                              | 0.002                                       | 0.004                                 | 100%A  |
| N128 SL                  | 323.841                         | 111.8                                    | 0.011                              | 0.098                                       | 0.040                                 | 5%S+95%A   |
| N129 SL                  | 298.946                         | 125.2                                    | 0.01                               | 0.068                                       | 0.068                                 | 2%S+98%A   |
| With Primer Madewell 927 |                                 |  |                                    |   |                                       |  |
| N127P*                   | 290.985                         | 209                                      | 0.003                              | 1.608                                       | 0.273                                 | 100%S  |
| N128P                    | 323.841                         | 364.2                                    | 0.009                              | 0.295                                       | 0.081                                 | 20%S+80%A  |
| N129P                    | 298.946                         | 359.3                                    | 0.017                              | 0.053                                       | 0.053                                 | 50%S+50%A  |

Table 21A. Adhesive Madewell 1312 at Temperature 100°F.

| TEST                     | Mass of<br>Mortar Cube<br>grams | Peak Load to<br>pull off dolly<br>pounds | Adhesive Film<br>Thickness<br>inch | Pulled off Mass<br>of Mortar Layer<br>grams | Max Height of<br>Mortar Layer<br>inch | Type of Failure<br>S=substrate<br>A=adhesive<br>C=cohesive |
|--------------------------|---------------------------------|--|------------------------------------|---|---------------------------------------|--|
| Without Primer           |                                 |  |                                    |   |                                       |  |
| RH=50%                   |                                 |  |                                    |   |                                       |  |
| N97R                     | 280.561                         | 352.0                                    | 0.005                              | 0.497                                       | 0.070                                 | 98%S+2%A   |
| N98R                     | 283.215                         | 277.0                                    | 0.004                              | 0.509                                       | 0.085                                 | 100%S  |
| N99R                     | 279.572                         | 453.0                                    | 0.002                              | 0.468                                       | 0.060                                 | 100%S  |
| RH=65%                   |                                 |  |                                    |   |                                       |  |
| N107                     | 287.55                          | 243.8                                    | 0.003                              | 0.330                                       | 0.069                                 | 95%S+5%A   |
| N108*                    | 285.745                         | 320.4                                    | 0.004                              | 1.565                                       | 0.168                                 | 100%S  |
| N109                     | 287.488                         | 342.7                                    | 0.003                              | 0.552                                       | 0.072                                 | 100%S  |
| RH=80%                   |                                 |  |                                    |   |                                       |  |
| N117                     | 306.328                         | 429.4                                    | 0.004                              | 0.345                                       | 0.087                                 | 75%S+25%A  |
| N118 SL                  | 309.997                         | 265.1                                    | 0.005                              | 0.785                                       | 0.126                                 | 100%S  |
| N119 SL                  | 287.058                         | 194.5                                    | 0.003                              | 0.955                                       | 0.124                                 | 100%S  |
| RH=95%                   |                                 |  |                                    |   |                                       |  |
| N127X                    | 290.985                         | 0  | 0.003                              | 0.002                                       | 0.004                                 | 100%A  |
| N128 SL                  | 323.841                         | 111.8                                    | 0.011                              | 0.098                                       | 0.040                                 | 5%S+95%A   |
| N129 SL                  | 298.946                         | 125.2                                    | 0.01                               | 0.068                                       | 0.068                                 | 2%S+98%A   |
| With Primer Madewell 927 |                                 |  |                                    |   |                                       |  |
| RH=50%                   |                                 |  |                                    |   |                                       |  |
| N97PR                    | 286.211                         | 428.2                                    | 0.003                              | 0.969                                       | 0.135                                 | 100%S  |
| N98PR                    | 281.546                         | 468.0                                    | 0.009                              | 0.642                                       | 0.095                                 | 100%S  |
| N99PR                    | 290.306                         | 412.8                                    | 0.003                              | 0.236                                       | 0.057                                 | 98%S+2%A   |
| RH=65%                   |                                 |  |                                    |   |                                       |  |
| N107P                    | 287.55                          | 292.2                                    | 0.03                               | 0.530                                       | 0.067                                 | 95%S+5%A   |
| N108P                    | 285.745                         | 312.5                                    | 0.002                              | 0.270                                       | 0.090                                 | 40%S+60%A  |
| N109P                    | 287.488                         | 327.9                                    | 0.004                              | 0.619                                       | 0.075                                 | 100%S  |
| RH=80%                   |                                 |  |                                    |   |                                       |  |
| N117P                    | 306.328                         | 287.1                                    | 0.007                              | 1.117                                       | 0.133                                 | 100%S  |
| N118P                    | 309.997                         | 371.9                                    | 0.008                              | 0.255                                       | 0.030                                 | 100%S(thin lyr)  |
| N119P                    | 287.058                         | 350.3                                    | 0.003                              | 0.630                                       | 0.074                                 | 98%S+2%A   |
| RH=95%                   |                                 |  |                                    |   |                                       |  |
| N127P*                   | 290.985                         | 209                                      | 0.003                              | 1.608                                       | 0.273                                 | 100%S  |
| N128P                    | 323.841                         | 364.2                                    | 0.009                              | 0.295                                       | 0.081                                 | 20%S+80%A  |
| N129P                    | 298.946                         | 359.3                                    | 0.017                              | 0.053                                       | 0.053                                 | 50%S+50%A  |

Table 21B. Adhesive Madewell 1312 at Temperature 100°F.

| TEST                     | Mass of<br>Mortar Cube<br>grams | Peak Load to<br>pull off dolly<br>pounds | Adhesive Film<br>Thickness<br>inch | Pulled off Mass<br>of Mortar Layer<br>grams | Max Height of<br>Mortar Layer<br>inch | Type of Failure<br>S=substrate<br>A=adhesive<br>C=cohesive |
|--------------------------|---------------------------------|--|------------------------------------|---|---------------------------------------|--|
| Without Primer           |                                 |  |                                    |   |                                       |  |
| RH=50%                   |                                 |  |                                    |   |                                       |  |
| N97R                     | 280.561                         | 352.0                                    | 0.005                              | 0.497                                       | 0.070                                 | 98%S+2%A   |
| N98R                     | 283.215                         | 277.0                                    | 0.004                              | 0.509                                       | 0.085                                 | 100%S  |
| N99R                     | 279.572                         | 453.0                                    | 0.002                              | 0.468                                       | 0.060                                 | 100%S  |
| Average                  |                                 | <b>360.7</b>                             | <b>0.004</b>                       | <b>0.491</b>                                | <b>0.072</b>                          |  |
| RH=65%                   |                                 |  |                                    |   |                                       |  |
| N107                     | 287.55                          | 243.8                                    | 0.003                              | 0.330                                       | 0.069                                 | 95%S+5%A   |
| N108*                    | 285.745                         | 320.4                                    | 0.004                              | 1.565                                       | 0.168                                 | 100%S  |
| N109                     | 287.488                         | 342.7                                    | 0.003                              | 0.552                                       | 0.072                                 | 100%S  |
| Average                  |                                 | <b>302.3</b>                             | <b>0.003</b>                       | <b>0.816</b>                                | <b>0.103</b>                          |  |
| RH=80%                   |                                 |  |                                    |   |                                       |  |
| N117                     | 306.328                         | 429.4                                    | 0.004                              | 0.345                                       | 0.087                                 | 75%S+25%A  |
| N118 SL                  | 309.997                         | 265.1                                    | 0.005                              | 0.785                                       | 0.126                                 | 100%S  |
| N119 SL                  | 287.058                         | 194.5                                    | 0.003                              | 0.955                                       | 0.124                                 | 100%S  |
| Average                  |                                 | <b>296.3</b>                             | <b>0.004</b>                       | <b>0.695</b>                                | <b>0.112</b>                          |  |
| RH=95%                   |                                 |  |                                    |   |                                       |  |
| N127X                    | 290.985                         | 0  | 0.003                              | 0.002                                       | 0.004                                 | 100%A  |
| N128 SL                  | 323.841                         | 111.8                                    | 0.011                              | 0.098                                       | 0.040                                 | 5%S+95%A   |
| N129 SL                  | 298.946                         | 125.2                                    | 0.01                               | 0.068                                       | 0.068                                 | 2%S+98%A   |
| Average                  |                                 | <b>118.5</b>                             | <b>0.008</b>                       | <b>0.056</b>                                | <b>0.037</b>                          |  |
| With Primer Madewell 927 |                                 |  |                                    |   |                                       |  |
| RH=50%                   |                                 |  |                                    |   |                                       |  |
| N97PR                    | 286.211                         | 428.2                                    | 0.003                              | 0.969                                       | 0.135                                 | 100%S  |
| N98PR                    | 281.546                         | 468.0                                    | 0.009                              | 0.642                                       | 0.095                                 | 100%S  |
| N99PR                    | 290.306                         | 412.8                                    | 0.003                              | 0.236                                       | 0.057                                 | 98%S+2%A   |
| Average                  |                                 | <b>436.3</b>                             | <b>0.005</b>                       | <b>0.616</b>                                | <b>0.096</b>                          |  |
| RH=65%                   |                                 |  |                                    |   |                                       |  |
| N107P                    | 287.55                          | 292.2                                    | 0.03                               | 0.530                                       | 0.067                                 | 95%S+5%A   |
| N108P                    | 285.745                         | 312.5                                    | 0.002                              | 0.270                                       | 0.090                                 | 40%S+60%A  |
| N109P                    | 287.488                         | 327.9                                    | 0.004                              | 0.619                                       | 0.075                                 | 100%S  |
| Average                  |                                 | <b>310.9</b>                             | <b>0.012</b>                       | <b>0.473</b>                                | <b>0.077</b>                          |  |
| RH=80%                   |                                 |  |                                    |   |                                       |  |
| N117P                    | 306.328                         | 287.1                                    | 0.007                              | 1.117                                       | 0.133                                 | 100%S  |
| N118P                    | 309.997                         | 371.9                                    | 0.008                              | 0.255                                       | 0.030                                 | 100%S(thin lyr)  |
| N119P                    | 287.058                         | 350.3                                    | 0.003                              | 0.630                                       | 0.074                                 | 98%S+2%A   |
| Average                  |                                 | <b>336.4</b>                             | <b>0.006</b>                       | <b>0.667</b>                                | <b>0.079</b>                          |  |
| RH=95%                   |                                 |  |                                    |   |                                       |  |
| N127P*                   | 290.985                         | 209                                      | 0.003                              | 1.608                                       | 0.273                                 | 100%S  |
| N128P                    | 323.841                         | 364.2                                    | 0.009                              | 0.295                                       | 0.081                                 | 20%S+80%A  |
| N129P                    | 298.946                         | 359.3                                    | 0.017                              | 0.053                                       | 0.053                                 | 50%S+50%A  |
| Average                  |                                 | <b>310.8</b>                             | <b>0.01</b>                        | <b>0.652</b>                                | <b>0.136</b>                          |  |

Table 21C. Adhesive Madewell 1312 at Temperature 100°F.

| TEST                     | Peak Load to<br>pull off dolly<br>pounds | Adhesive Film<br>Thickness<br>inch | Pulled off Mass<br>of Mortar Layer<br>grams | Max Height of<br>Mortar Layer<br>inch |
|--------------------------|--|------------------------------------|---|---------------------------------------|
| Without Primer           |  |                                    |   |                                       |
| RH%                      |  |                                    |   |                                       |
| 50                       | 360.7                                    | 0.004                              | 0.491                                       | 0.072                                 |
| 65                       | 302.3                                    | 0.003                              | 0.816                                       | 0.103                                 |
| 80                       | 296.3                                    | 0.004                              | 0.695                                       | 0.112                                 |
| 95                       | 118.5                                    | 0.008                              | 0.056                                       | 0.037                                 |
| With Primer Madewell 927 |  |                                    |   |                                       |
| RH%                      |  |                                    |   |                                       |
| 50                       | 436.3                                    | 0.005                              | 0.616                                       | 0.096                                 |
| 65                       | 310.9                                    | 0.012                              | 0.473                                       | 0.077                                 |
| 80                       | 336.4                                    | 0.006                              | 0.667                                       | 0.079                                 |
| 95                       | 310.8                                    | 0.010                              | 0.652                                       | 0.136                                 |

Data rearranged for plotting

| RH% | No Primer | With Primer |
|-----|-----------|-------------|
| 50  | 360.7     | 436.3       |
| 65  | 302.3     | 310.9       |
| 80  | 296.3     | 336.4       |
| 95  | 118.5     | 310.8       |



Table 22. Distribution of Types of Failures.

TEMPERATURE = 70 DEG F

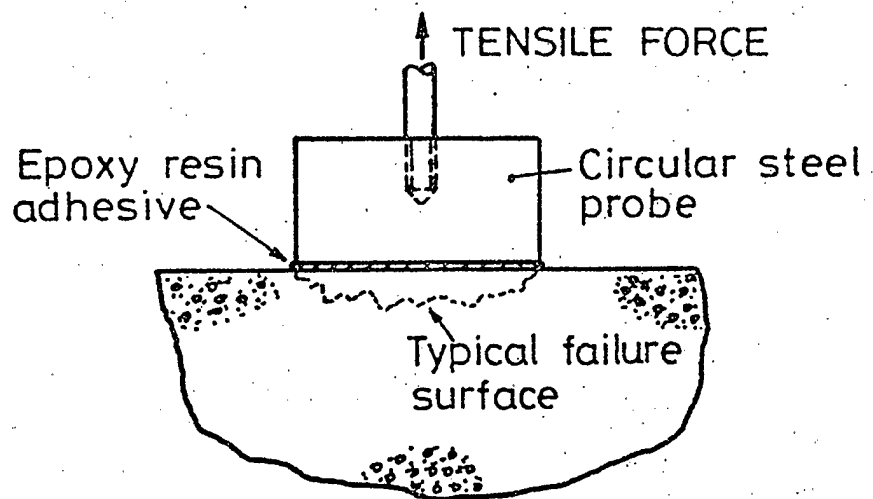
| RH%      | Substrate<br>100% | Substrate<br>99%-80% | Substrate<br>79%-60% | Substrate<br>59%-1% | Adhesive<br>100% | Cohesive<br>100% | Total |
|----------|-------------------|----------------------|----------------------|---------------------|------------------|------------------|-------|
| 50(Set1) | 18                | 0                    | 0                    | 0                   | 0                | 0                | 18    |
| 65(Set2) | 12                | 5                    | 0                    | 1                   | 0                | 0                | 18    |
| 80(Set3) | 10                | 5                    | 1                    | 2                   | 0                | 0                | 18    |
| 95(Set4) | 11                | 3                    | 0                    | 4                   | 0                | 0                | 18    |
| Total A  | 51                | 13                   | 1                    | 7                   | 0                | 0                | 72    |

TEMPERATURE = 85 DEG F

|          |    |    |   |   |   |   |    |
|----------|----|----|---|---|---|---|----|
| 50(Set5) | 9  | 6  | 2 |   | 1 | 0 | 18 |
| 65(Set6) | 11 | 4  | 2 | 1 | 0 | 0 | 18 |
| 80(Set7) | 11 | 5  | 0 | 2 | 0 | 0 | 18 |
| 95(Set8) | 13 | 5  | 0 | 0 | 0 | 0 | 18 |
| Total B  | 44 | 20 | 4 | 3 | 1 | 0 | 72 |

TEMPERATURE = 100 DEG F

|           |     |    |    |    |   |   |     |
|-----------|-----|----|----|----|---|---|-----|
| 50(Set9)  | 11  | 5  | 1  | 1  | 0 | 0 | 18  |
| 65(Set10) | 8   | 7  | 2  | 1  | 0 | 0 | 18  |
| 80(Set11) | 10  | 2  | 4  | 2  | 0 | 0 | 18  |
| 95(Set12) | 3   | 3  | 1  | 8  | 2 | 1 | 18  |
| Total C   | 32  | 17 | 8  | 12 | 2 | 1 | 72  |
| A+B+C     | 127 | 50 | 13 | 22 | 3 | 1 | 216 |



Arrangement for testing uncored specimens

Figure 1: Original Version of Pull-Off Test (after A. E. Long)

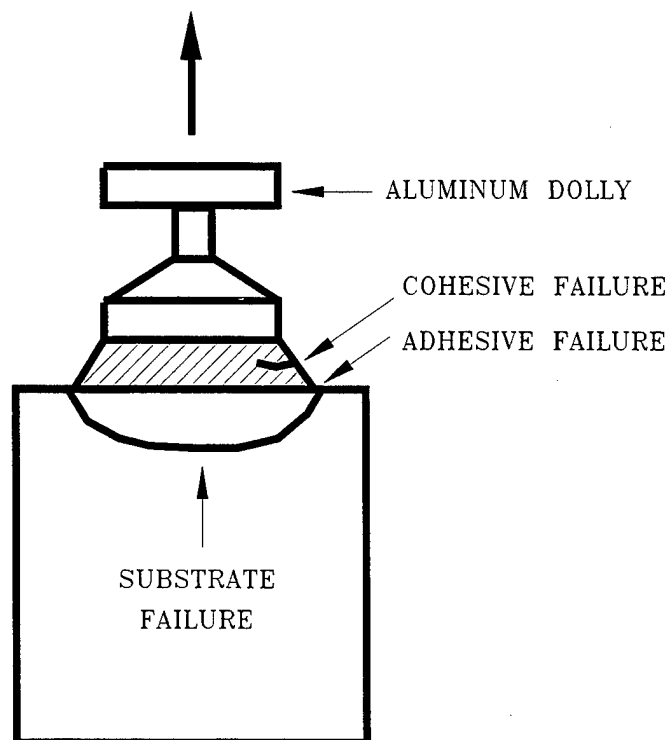


Figure 2: Schematic of Different Types of Failures

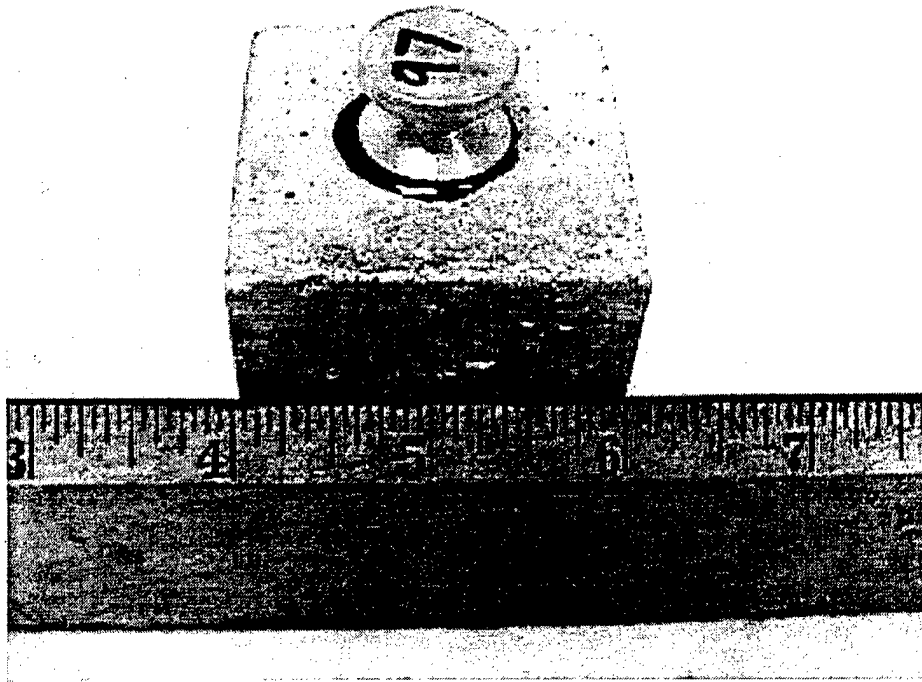


Figure 3: Photo of Dolly attached to Cement Mortar Cube showing Dimensions

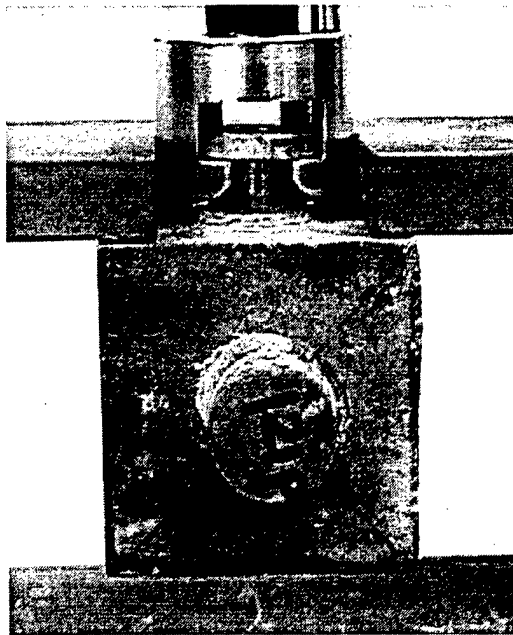


Figure 4: Special Fixture for Pull-Off Test with Instron Testing Machine

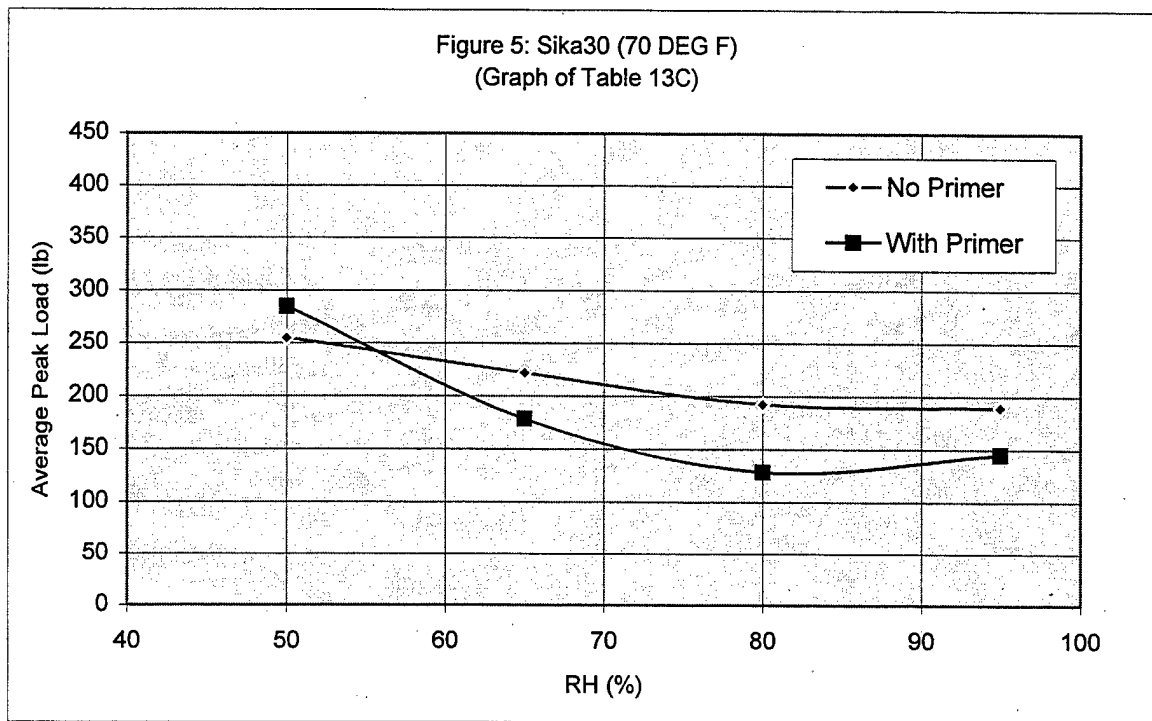


Figure 5: Sika 30 at 70°F

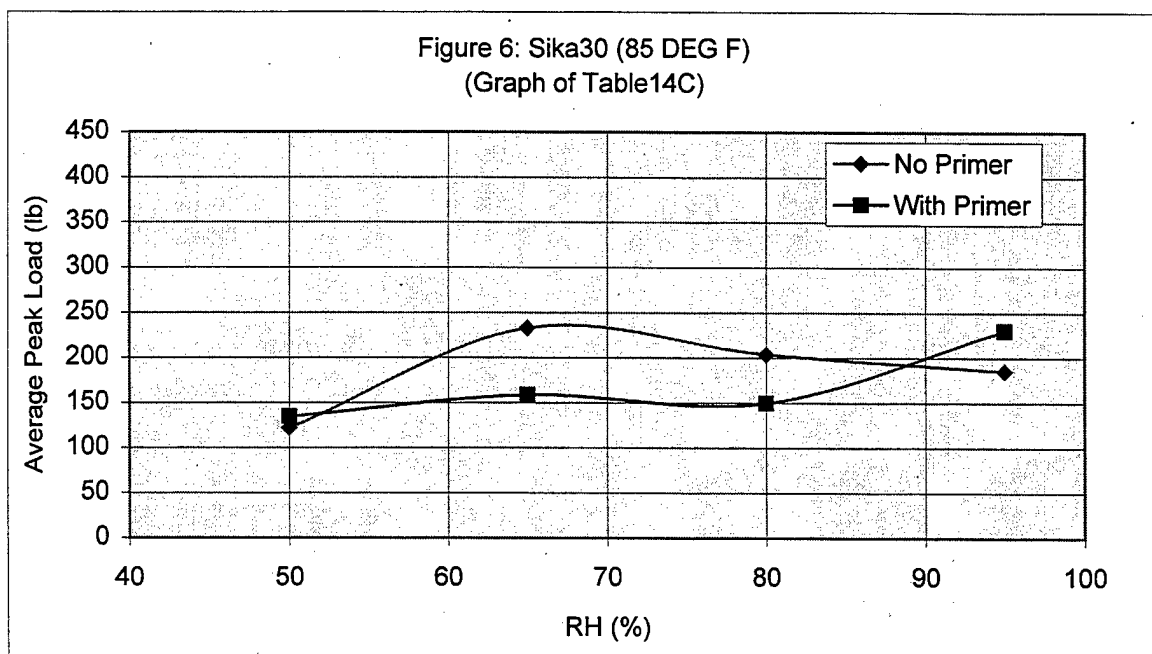


Figure 6: Sika 30 at 85°F

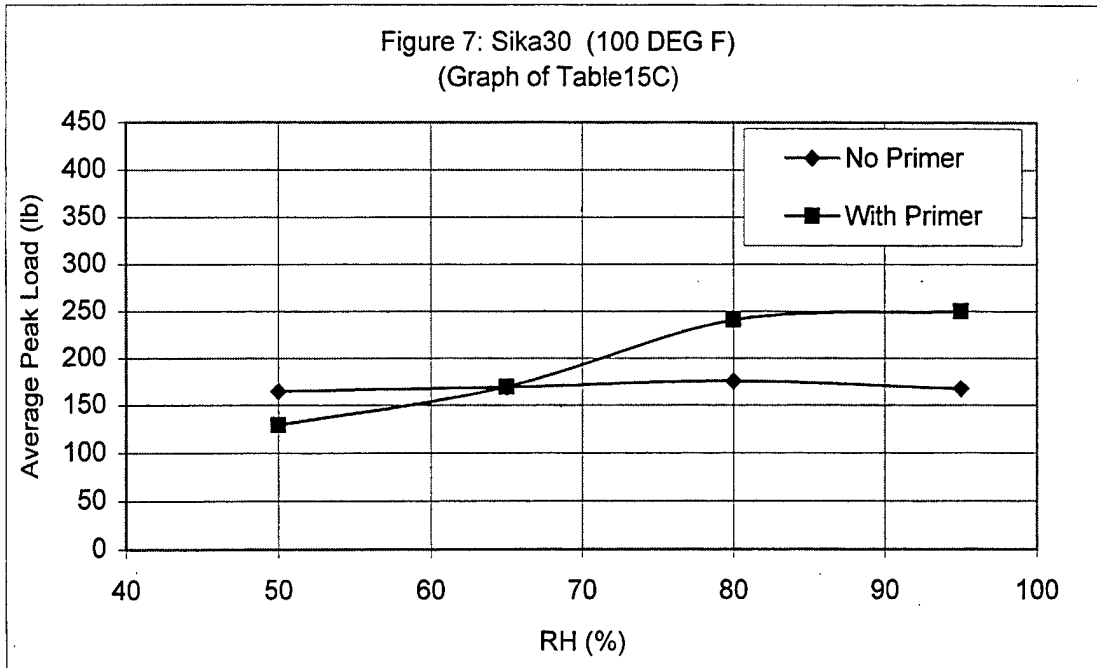


Figure 7: Sika 30 at 100°F

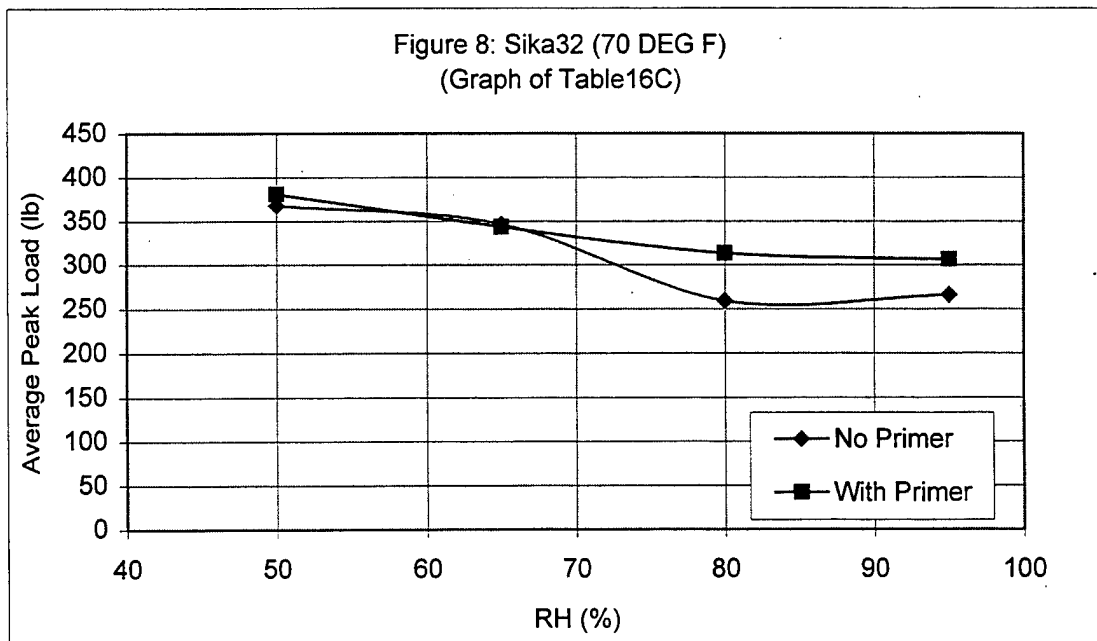


Figure 8: Sika 32 at 70°F

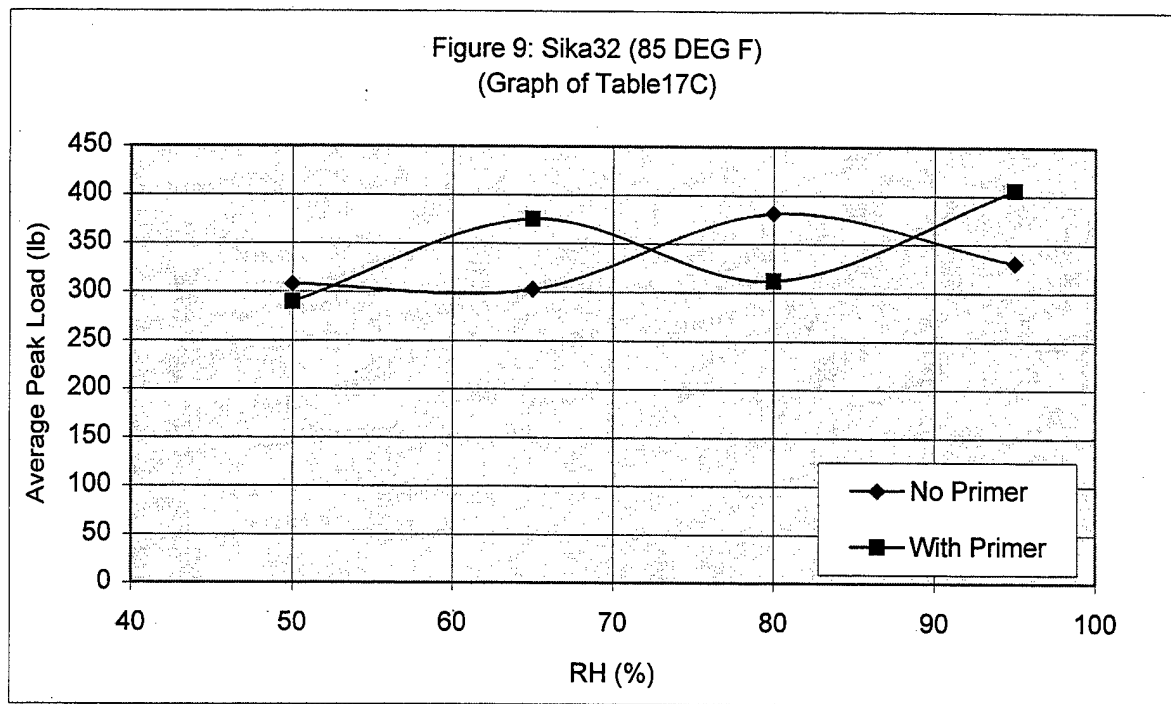


Figure 9: Sika 32 at 85°F

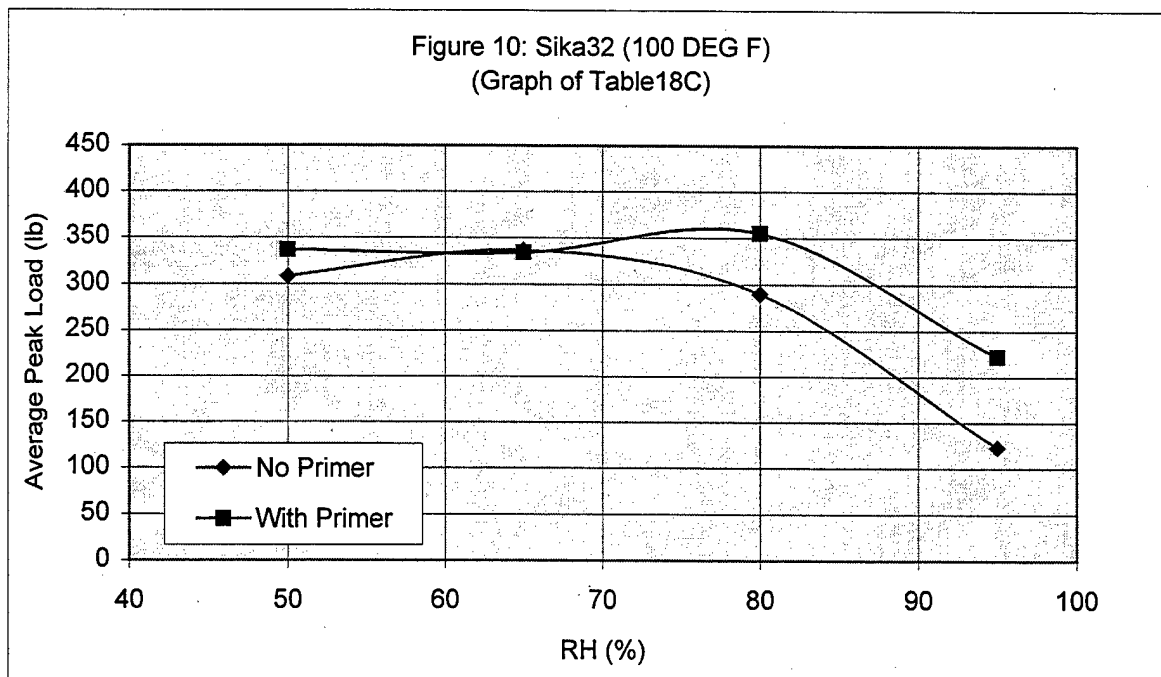


Figure 10: Sika 32 at 100°F

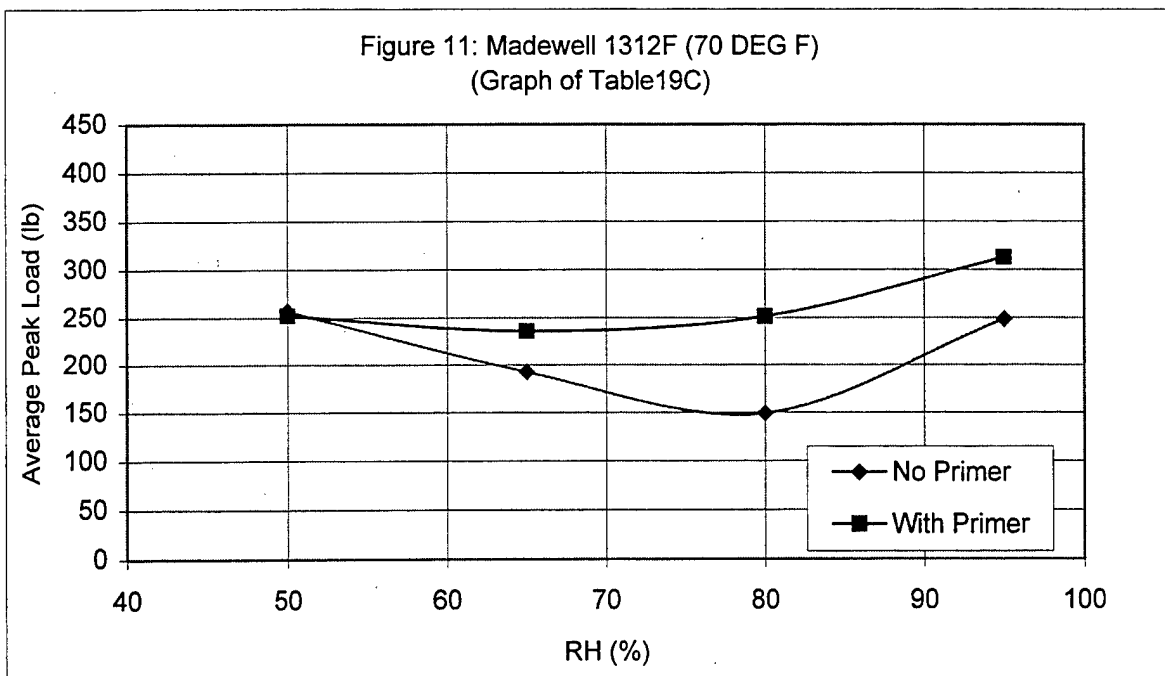


Figure 11: Madewell 1312 at 70°F

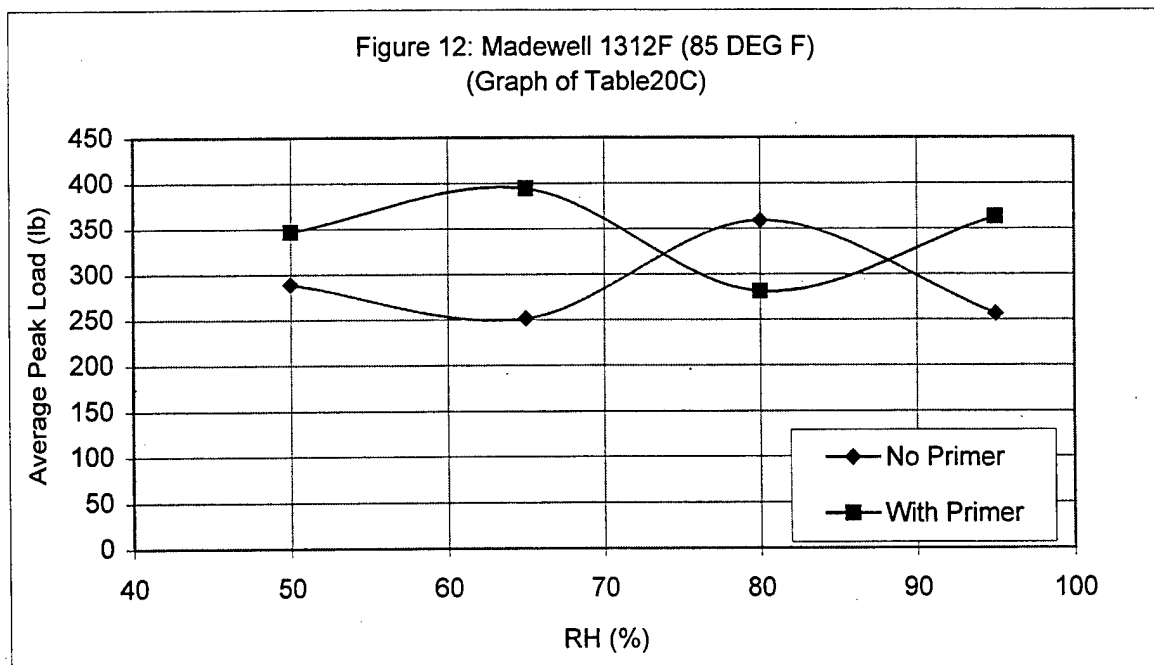


Figure 12: Madewell 1312 at 85°F

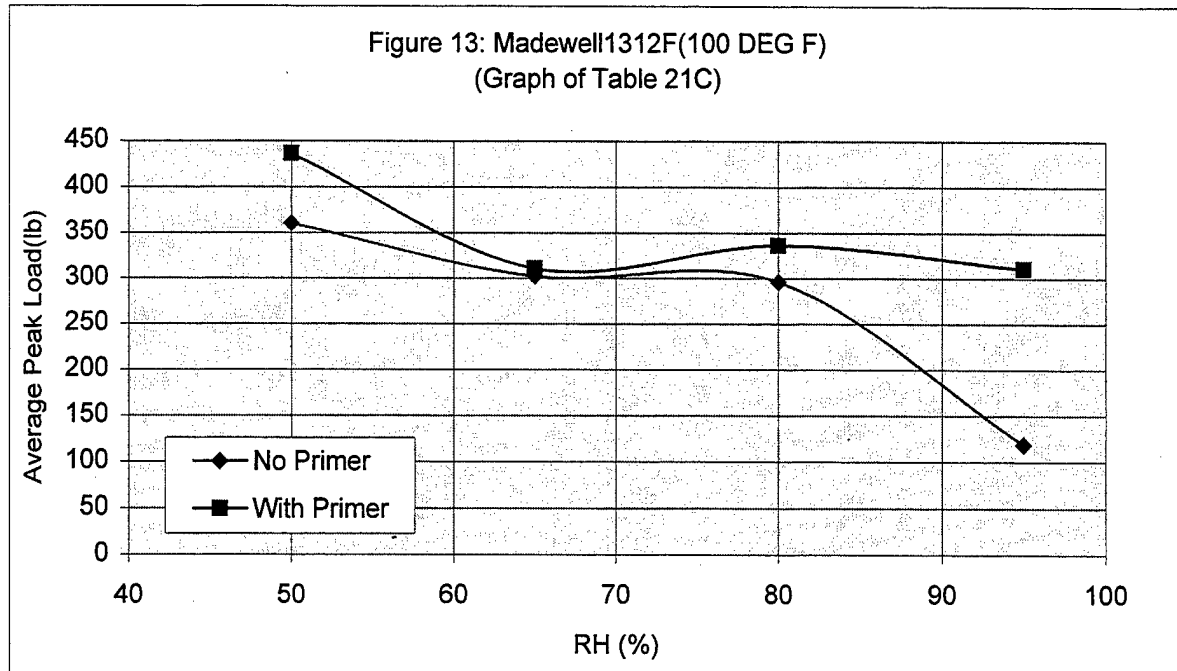


Figure 13: Madewell 1312 at 100°F

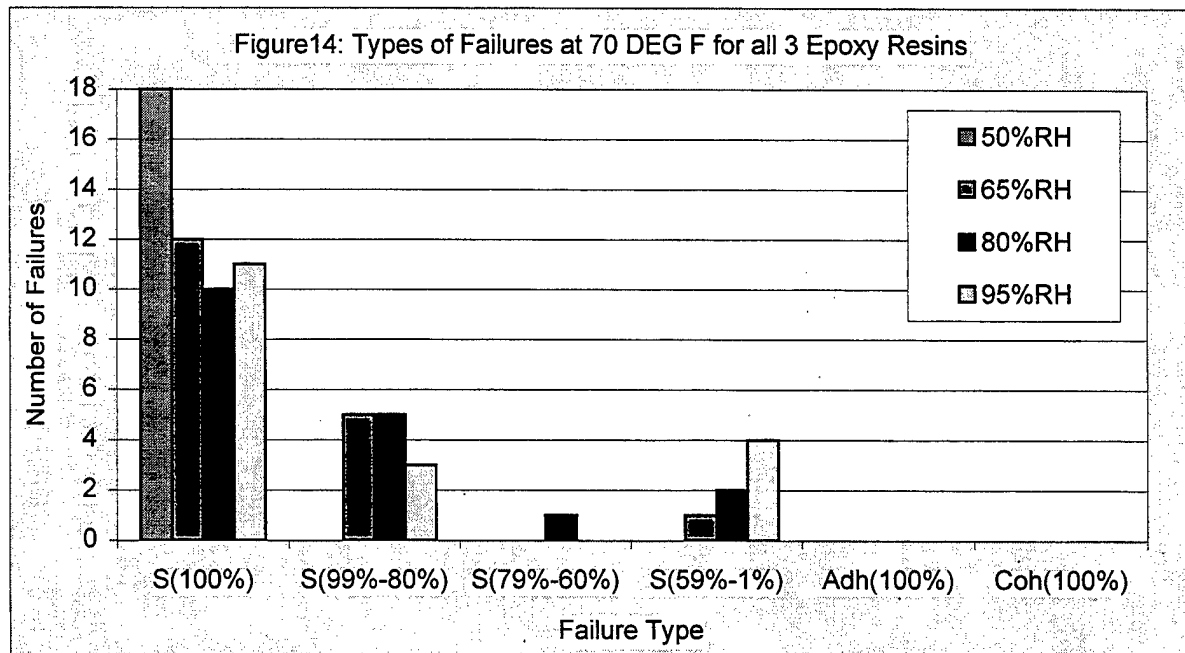


Figure 14: Failure Types at 70°F



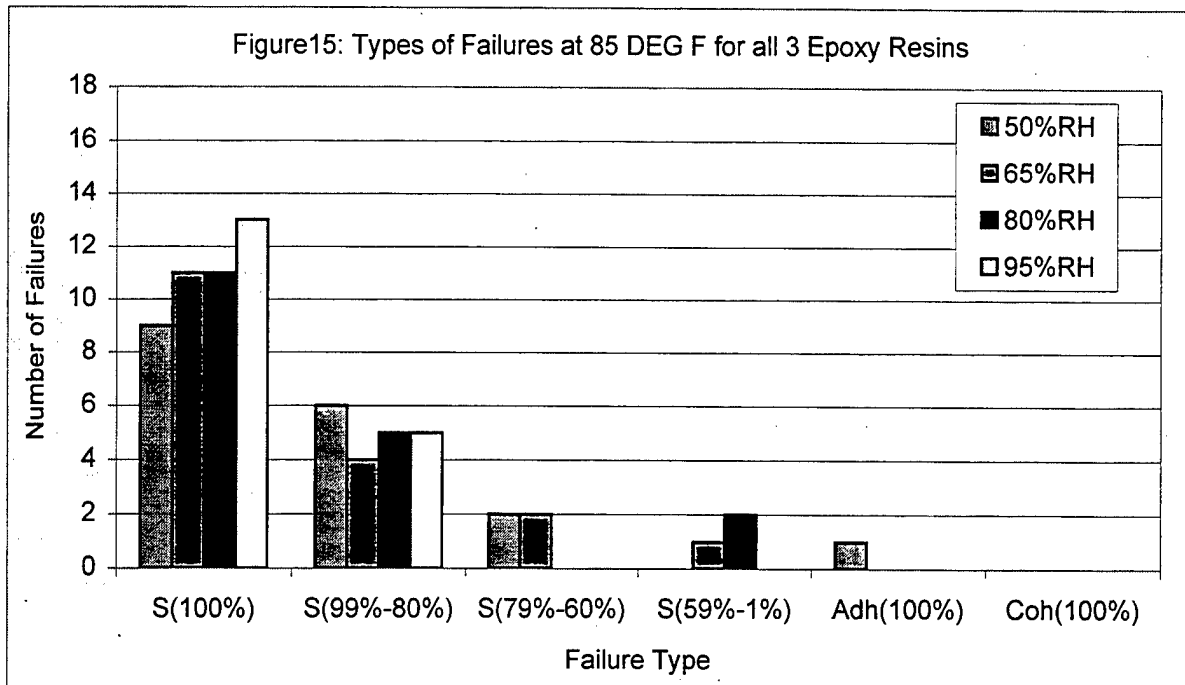


Figure 15: Failure Types at 85°F

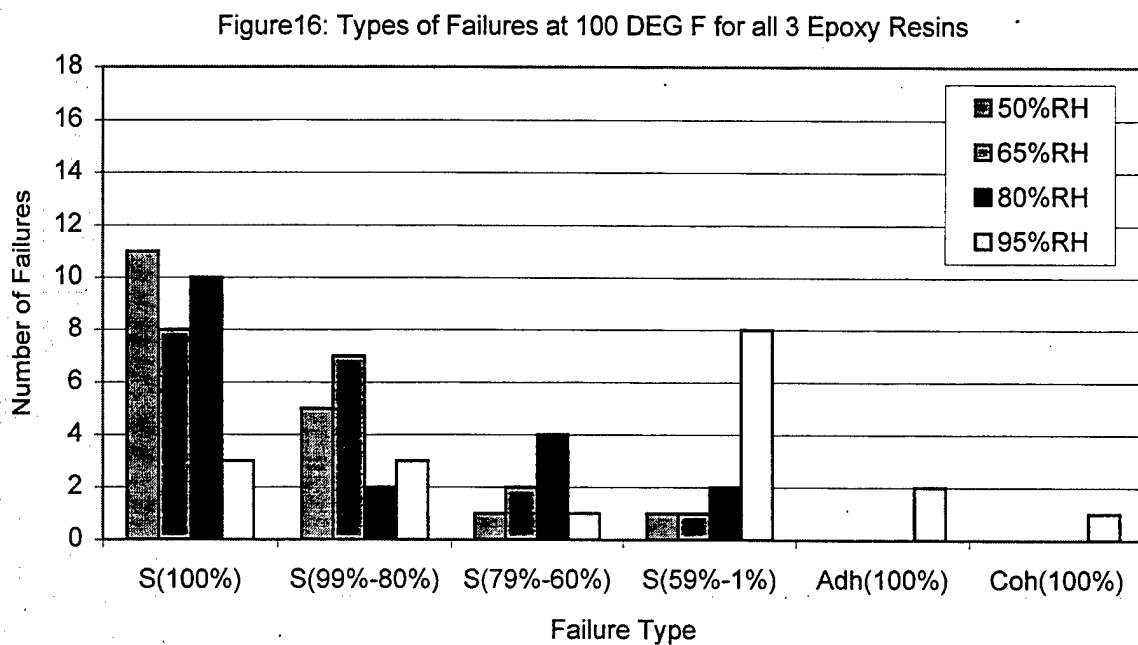


Figure 16: Failure Types at 100°F

## **APPENDIX A**

This appendix includes data for the various adhesives and primers used. Data were obtained and summarized from the manufacturer's specifications.

Table A1. Properties of Sikadur 30

|  |   |   |  |
|--|---|---|--|
| <b>TYPICAL DATA FOR SIKADUR 30</b><br>(Material and curing conditions @ 73F and 50% R.H.)<br>Sikadur 30 is a 2-component, 100% solids, moisture-tolerant structural epoxy paste adhesive |   |   |  |
| <b>SHELF LIFE</b>  |   | 2 years in original, unopened containers.                       |  |
| <b>STORAGE CONDITIONS</b>  |   | Store dry at 40-95F. Condition material to 65-85F before using. |  |
| <b>COLOR</b>   |   | Light gray.   |  |
| <b>MIXING RATIO</b>  |   | Component 'A': Component 'B' = 3:1 by volume.                   |  |
| <b>CONSISTENCY</b>   |   | Non-sag paste.  |  |
| <b>POT LIFE</b>  |   | Approximately 70 minutes @ 73F. (1 qt.)                         |  |
| <b>TENSILE PROPERTIES (ASTM D-638)</b>   |   |   |  |
| 7 day  | Tensile Strength  | 3,600 psi (24.8 MPa)  |  |
|  | Elongation at Break                                     | 1%  |  |
|  | Modulus of Elasticity                                   | 6.5 X 10 <sup>5</sup> psi                                       |  |
| <b>FLEXURAL PROPERTIES (ASTM D-790)</b>  |   |   |  |
| 14 day   | Flexural Strength (Modulus of Rupture)                  | 6,800 psi (46.8 MPa)  |  |
|  | Tangent Modulus of Elasticity In Bending                | 1.7 x 10 <sup>6</sup> psi                                       |  |
| <b>SHEAR STRENGTH (ASTM D-790)</b>   |   | 14 day  | Shear Strength                      3,600 psi (24.8 MPa) |
| <b>BOND STRENGTH (ASTM C-882): Hardened Concrete to Hardened Concrete</b>  |   |   |  |
| 2 day  | (moist cure)  | Bond Strength   | 2,700 psi (18.6 MPa)                                     |
| 2 day  | (dry cure)  | Bond Strength   | 3,200 psi (22.0 MPa)                                     |
| 14 day   | (moist cure)  | Bond Strength   | 3,100 psi (21.3 MPa)                                     |
| <b>Hardened Concrete to Steel</b>  |   |   |  |
| 2 day  | (moist cure)  | Bond Strength   | 2,600 psi (17.9 MPa)                                     |
| 2 day  | (moist cure)  | Bond Strength   | 3,000 psi (20.6 MPa)                                     |
| 14 day   | (moist cure)  | Bond Strength   | 2,600 psi (17.9 MPa)                                     |
| <b>DEFLECTION TEMPERATURE (ASTM D-648)</b>   |   |   |  |
| 7 day  | Deflection Temperature (fiber stress loading = 264 psi) |   | 118F (47C)   |
| <b>WATER ABSORPTION (ASTM D-570)</b>   |   |   |  |
| 24 hours   | Total Water Absorption                                  |   | 0.03%  |
| <b>COMPRESSIVE PROPERTIES (ASTM D-695)</b>   |   |   |  |
| Compressive Strength, psi  | <b>40F</b>  | <b>73F</b>  | <b>90F</b>   |
| 4 hour   | -   |   | 5,500 (37.9 MPa)   |
| 8 hour   | -   | 3,500 (24.1 MPa)  | 6,700 (46.2 MPa)   |
| 16 hour  | -   | 6,700 (46.2 MPa)  | 7,400 (51.0 MPa)   |
| 1 day  | 750 (5.1 MPa)   | 7,800 (53.7 MPa)  | 7,800 (53.7 MPa)   |
| 3 day  | 6,800 (46.8 MPa)  | 8,300 (57.2 MPa)  | 8,300 (57.2 MPa)   |
| 7 day  | 8,000 (55.1 MPa)  | 8,600 (59.3 MPa)  | 8,600 (59.3 MPa)   |
| 14 day   | 8,500 (58.6 MPa)  | 8,600 (59.3 MPa)  | 8,900 (61.3 MPa)   |
| 28 day   | 8,500 (58.6 MPa)  | 8,600 (59.3 MPa)  | 9,000 (62.0 MPa)   |
| <b>MODULUS OF ELASTICITY, PSI</b>  |   | 7 day   | 3.9 X 10 <sup>5</sup> psi                                |

Table A2. Properties of Sikadur 32 Hi-Mod

|   |   |  |                      |
|---|---|--|----------------------|
| <b>TYPICAL DATA FOR SIKADUR 32 HI-MOD</b><br>(Material and curing conditions @ 73F and 50% R.H.)<br>Sikadur 32 is a 2-component, 100% solids, moisture-tolerant structural epoxy paste adhesive |   |  |                      |
| <b>SHELF LIFE</b>   | 2 years in original, unopened containers.                       |  |                      |
| <b>STORAGE CONDITIONS</b>   | Store dry at 40-95F. Condition material to 65-75F before using. |  |                      |
| <b>COLOR</b>  | Concrete gray.  |  |                      |
| <b>MIXING RATIO</b>   | Component 'A': Component 'B' = 1:1 by volume.                   |  |                      |
| <b>VISCOSITY</b>  | Approximately 2,800 cps.  |  |                      |
| <b>POT LIFE</b>   | Approximately 30 minutes. (60 gram mass)                        |  |                      |
| <b>CONTACT TIME</b>   | 40F<br>14-16 hr   | 73F<br>3.5-4 hr                        | 90F<br>1.5-2 hr      |
| <b>COMPRESSIVE MODULUS, PSI:</b>  | 7 day   | 2.0 x 10 <sup>5</sup> psi (1379.3 MPa) |                      |
| <b>TENSILE PROPERTIES (ASTM D-638)</b>  |   |  |                      |
| 7 day   | Tensile Strength  | 5,100 psi (35.1 MPa)                   |                      |
|   | Elongation at Break   | 1.8%                                   |                      |
| 14 day  | Modulus of Elasticity   | 3.2 X 10 <sup>5</sup> psi (2206.9 MPa) |                      |
| <b>FLEXURAL PROPERTIES (ASTM D-790)</b>   |   |  |                      |
| 14 day  | Flexural Strength<br>(Modulus of Rupture)                       | 7,400 psi (51 MPa)                     |                      |
|   | Tangent Modulus of Elasticity<br>In Bending                     | 4.7 X 10 <sup>5</sup> psi              |                      |
| <b>SHEAR STRENGTH (ASTM D-790)</b>  | 14 day  | Shear Strength                         | 5,900 psi (40.6 MPa) |
| <b>WATER ABSORPTION (ASTM D-570)</b>  | 24 hours  | Total Water Absorption                 | 0.79%                |
| <b>DEFLECTION TEMPERATURE (ASTM D-648)</b>  |   |  |                      |
| 7 day   | Deflection Temperature<br>(fiber stress loading = 264 psi)      | 121F                                   |                      |
| <b>BOND STRENGTH (ASTM C-882): Hardened Concrete to Hardened Concrete</b>   |   |  |                      |
| 2 day (moist cure)  | Plastic Concrete to Hardened Concrete                           | 1,700 psi                              |                      |
| 14 day (moist cure)   | Plastic Concrete to Hardened Concrete                           | 2,400 psi                              |                      |
|   | Plastic Concrete to Steel                                       | 1,900 psi                              |                      |
| <b>COMPRESSIVE PROPERTIES (ASTM D-695)</b>  |   |  |                      |
| Compressive Strength, psi   | 40F   | 73F                                    | 90F                  |
| 8 hour  | -   | -                                      | 100 (.18 MPa)        |
| 16 hour   | -   | 2,400 (16.5 MPa)                       | 4,500 (31 MPa)       |
| 1 day   | -   | 4,600 (31.7 MPa)                       | 6,400 (44.1 MPa)     |
| 3 day   | 800 (5.5 MPa)   | 8,100 (55.8 MPa)                       | 8,200 (56.5 MPa)     |
| 7 day   | 8,100 (55.9 MPa)  | 10,300 (71 MPa)                        | 8,200 (56.5 MPa)     |
| 14 day  | 8,100 (55.9 MPa)  | 10,300 (71 MPa)                        | 8,200 (56.5 MPa)     |
| 28 day  | 8,800 (60.7 MPa)  | 10,300 (10,300 MPa)                    | 8,200 (56.5 MPa)     |

Table A3. Properties of Sikadur 55 SLV

|  |   |                           |                           |
|--|---|---------------------------|---------------------------|
| <b>TYPICAL DATA FOR SIKADUR 55 SLV</b><br>(Material and curing conditions @ 73F (23C) and 50% R.H.)<br>Sikadur 55 is a 2-component, 100% solids, moisture-tolerant epoxy crack healer/penetrating sealer. It is a super low viscosity hi-strength adhesive formulated specifically for grouting dry and damp cracks. |   |                           |                           |
| <b>SHELF LIFE</b>  | 2 years in original, unopened containers.                               |                           |                           |
| <b>STORAGE CONDITIONS</b>  | Store dry at 40-95F (4-35C). Condition material to 65-75F before using. |                           |                           |
| <b>COLOR</b>   | Clear, amber  |                           |                           |
| <b>MIXING RATIO</b>  | Component 'A': Component 'B' = 2:5:1 by volume.                         |                           |                           |
| <b>VISCOSITY</b>   | Approximately 95 cps  |                           |                           |
| <b>POT LIFE</b>  | Approximately 25 minutes  |                           |                           |
| <b>TACK FREE TIME</b>  | <b>40F</b>  | <b>60F</b>                | <b>73F</b>                |
|  | -   | 16 hours                  | 6 hours                   |
| <b>TENSILE PROPERTIES (ASTM D-638)</b>   |   |                           |                           |
|  | <b>40F</b>  | <b>60F</b>                | <b>73F</b>                |
| 7 day Tensile Strength   | -   | 5,000psi (34.4 MPa)       | 7,500psi (51.7 MPa)       |
| Elongation at Break  | -   | 1.6%                      | 2.3%                      |
| <b>BOND STRENGTH (ASTM C-882)</b>  |   |                           |                           |
| Hardened Concrete to Hardened Concrete   |   |                           |                           |
| 2 day (moist cure)   |   | 1,400 psi (9.6 MPa)       |                           |
| 14 day (moist cure)  |   | 2,700 psi (18.6 MPa)      |                           |
| Hardened Concrete to Steel   |   |                           |                           |
| 2 day (moist cure)   |   | 1,800 psi (12.4 MPa)      |                           |
| 14 day (moist cure)  |   | 2,000 psi (13.8 MPa)      |                           |
| <b>FLEXURAL PROPERTIES (ASTM D-790)</b>  |   |                           |                           |
| 7 day Flexural Strength  |   | 9,500 psi (65.5 MPa)      |                           |
| Tangent Modulus of Elasticity  |   | 4.8 x 10 <sup>5</sup> psi |                           |
| <b>SHEAR STRENGTH (ASTM D-790)</b>   | 14 day  | Shear Strength            | 7,600 psi (52.4 MPa)      |
| <b>DEFLECTION TEMPERATURE (ASTM D-648)</b>   | 7 day   |                           | 120F (49C)                |
| <b>WATER ABSORPTION (ASTM D-570)</b>   |   |                           |                           |
| 7 day Total Water Absorption (24 hour Immersion)   |   |                           | 0.61%                     |
| <b>COMPRESSIVE PROPERTIES (ASTM D-695)</b>   |   |                           |                           |
| Compressive Strength, psi  | <b>40F</b>  | <b>73F</b>                | <b>90F</b>                |
| 1 day  | -   | 250 (1.7 MPa)             | 5,150 (35.5 MPa)          |
| 3 day  | 1,200 (8.2 MPa)   | 11,600 (80 MPa)           | 12,900 (88.9 MPa)         |
| 7 day  | 7,900 (54.4 MPa)  | 13,700 (94.4 MPa)         | 14,800 (102 MPa)          |
| 14 day   | 12,600 (86.8 MPa)   | 14,000 (96.5 MPa)         | 15,300 (105.5 MPa)        |
| 28 day   | 13,000 (89.6 MPa)   | 14,000 (96.5 MPa)         | 15,800 (108.9 MPa)        |
| <b>MODULUS OF ELASTICITY, PSI</b>  | 7 day   |                           | 3.7 X 10 <sup>5</sup> psi |

Table A4. Properties of Madewell 1312F

|   |  |            |            |
|---|--|------------|------------|
| <b>TYPICAL DATA FOR MADEWELL 1312F</b><br><i>Madewell 1312F is a 2-component, 100% solids, epoxy saturant (resin) specifically designed for use with glass, carbon or other synthetic fiber reinforcement systems for protection and/or reinforcement of concrete, steel, wood or composite structures.</i> |  |            |            |
| <b>SHELF LIFE</b>   |  |            |            |
| <b>STORAGE CONDITIONS</b>   |  |            |            |
| <b>COLOR</b>  | Transparent blue   |            |            |
| <b>MIXING RATIO</b>   | Component 'A': Component 'B' = : by volume.                    |            |            |
| <b>VISCOSITY</b>  | Approximately cps  |            |            |
| <b>POT LIFE</b>   | Approximately 45 minutes at 100F, longer at lower temperatures |            |            |
| <b>TACK FREE TIME</b>   | <b>40F</b>   | <b>60F</b> | <b>73F</b> |
|   | -  |            |            |
| <b>TENSILE PROPERTIES (ASTM D-638)</b>  |  |            |            |
|   | <b>40F</b>   | <b>60F</b> | <b>73F</b> |
| 7 day Tensile Strength  | -  |            |            |
| Elongation at Break   | -  |            |            |
| <b>BOND STRENGTH (ASTM C-882)</b>   |  |            |            |
| Hardened concrete to hardened   |  |            |            |
| 2 day (moist cure)  |  |            |            |
| 14 day (moist cure)   |  |            |            |
| Hardened Concrete to Steel  |  |            |            |
| 2 day (moist cure)  |  |            |            |
| 14 day (moist cure)   |  |            |            |
| <b>FLEXURAL PROPERTIES (ASTM D-790)</b>   |  |            |            |
| 7 day Flexural Strength   |  |            |            |
| Tangent Modulus of Elasticity   |  |            |            |
| <b>SHEAR STRENGTH (ASTM D-790)</b>  |  |            |            |
| <b>DEFLECTION TEMPERATURE (ASTM D-648)</b> 7 day  |  |            |            |
| <b>WATER ABSORPTION (ASTM D-570)</b>  |  |            |            |
| 7 day Total Water Absorption (24 hour Immersion)  |  |            |            |
| <b>COMPRESSIVE PROPERTIES (ASTM D-695)</b>  |  |            |            |
| Compressive Strength, psi   | <b>40F</b>   | <b>73F</b> | <b>90F</b> |
| 1 day   | -  |            |            |
| 3 day   | -  |            |            |
| 7 day   | -  |            |            |
| 14 day  | -  |            |            |
| 28 day  | -  |            |            |
| <b>MODULUS OF ELASTICITY, PSI</b>   | 7 day  |            |            |